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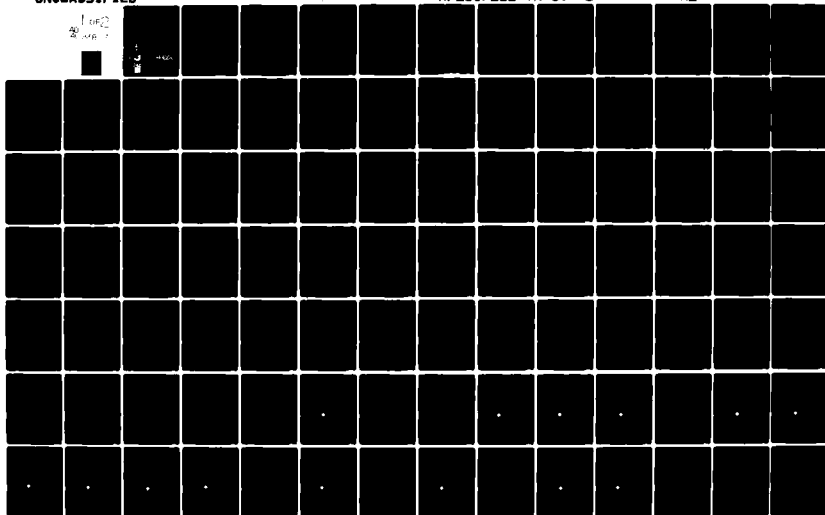
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SPILL ASSESSMENT MODEL (SAM) PROCEDURE FOR MANUAL FIELD CALCULATIONS

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20. ABSTRACT (CONCLUDED)

OF CERTAIN TYPES OF SPILLED CHEMICALS IN WATER AS DEVELOPED IN ESL-TR-80-07. THE CALCULATION PROCEDURES FOR FIELD USE HAVE BEEN DEVELOPED IN THE FORM OF A SERIES OF GRAPHS AND TABLES, AND PERMIT HAZARD EXTENT ESTIMATES TO BE RAPIDLY MADE WHEN TIME OR RESOURCES ARE NOT AVAILABLE FOR MORE COMPLEX COMPUTATION. THE DATA REQUIRED FOR THESE FIELD COMPUTATIONS CAN BE IMMEDIATELY OBTAINED OR ESTIMATED.

THE PROCEDURES FOR FIELD USE MAY BE APPLIED TO OBTAIN ESTIMATES OF THE CONCENTRATION IN WATER RESULTING FROM THE SPILL OF A SOLUBLE CHEMICAL HAVING A DENSITY CLOSE TO THAT OF WATER. IT IS ASSUMED THAT THE CHEMICAL IS FULLY SOLUBLE IN WATER, AND THAT ALL THE DISCHARGED CHEMICAL GOES INTO SOLUTION WITH WATER. IN PARTICULAR, EFFECTS OF CHEMICAL REACTIONS, PHASE CHANGES, OR VAPORIZATION FROM A SPREADING LIQUID ARE NOT INCORPORATED; THESE ASSUMPTIONS LEAD TO ESTIMATES OF CONCENTRATIONS IN WATER THAT ARE CONSERVATIVE. THE INTERACTIVE COMPUTER MODEL VERSION DISCUSSED IN ESL-TR-80-27 DOES NOT MAKE THESE ASSUMPTIONS.

SPECIFICALLY, THE PART OF SAM UTILIZED AS THE BASIS FOR THE FIELD CALCULATIONS ADDRESSES ONLY INSTANTANEOUS POINT SOURCE DISCHARGES INTO A FLOWING RIVER. FOR FIELD USE, THE PRIMARY REQUIREMENT IS TO ASSESS THE MAXIMUM CONCENTRATIONS WHICH MAY RESULT FROM A SPILL AT VARIOUS DISTANCES FROM THE SPILL LOCATION, AND TO DETERMINE THE MAXIMUM DISTANCES OVER WHICH THE CONCENTRATION IN WATER WILL EXCEED ANY SPECIFIED HAZARD LEVEL.

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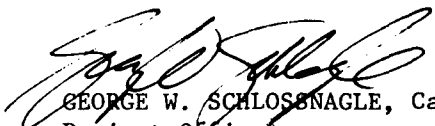
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PREFACE


This report was prepared by Arthur D. Little, Inc., Acorn Park, Cambridge, Massachusetts 02140 under Contract F08635-79-C-0084 with the Air Force Engineering and Service Center (AFESC), Tyndall Air Force Base, Florida 32403. Captain George W. Schlossnagle was Project Engineer for AFESC.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Service (NTIS). It will be available at NTIS to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.


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SECTION I

INTRODUCTION

Current U.S. Air Force operations dictate the use of numerous toxic substances, and among these are the three hydrazine family fuels (anhydrous, unsymmetrical dimethyl and monomethyl hydrazine). Hydrazine fuels are the basic rocket propellant for strategic missiles and satellites, and the joint NASA and U.S. Air Force sponsored Space Shuttle Program will greatly increase the volume of hydrazine in general use. Bulk storage and transport of hydrazine fuels could lead to accidental discharges, and if a discharge finds its way into a water body, undesirable consequences could occur to the aquatic ecosystem. The objective of the work described in this report was to develop a mathematical model for application in assessing the impact of catastrophic spills. The Spill Assessment Model, SAM, is now available at two levels: (1) this field manual which provides simple calculation procedures that can be rapidly applied to obtain estimates of hazard levels, and (2) an interactive computerized version of the model which allows a more detailed and precise analysis of spill events (ESL-TR-80-27). The model development is documented in ESL-TR-80-07.

The purpose of this manual is to provide a simple calculation procedure that can be rapidly applied in the field to obtain estimates of the potential extent of hazard levels from such a discharge. These field procedures have been derived from complex analytical and computer based models describing the behavior of certain types of spilled chemicals in water. The calculation procedures for field use have been developed in the form of a series of graphs and tables and permit hazard extent estimates to be rapidly

made when time or resources are not available for more complex computation. The data required for these field computations can be immediately obtained or estimated.

The calculations described in this manual necessarily incorporate a number of assumptions and limitations, the majority of which are reviewed in Section V. The procedures for field use may be applied to obtain estimates of the concentration in water resulting from the spill of a soluble chemical having a density close to that of water. It is assumed that the chemical is fully soluble in water, and that all the discharged chemical goes into solution with water. In particular, effects of chemical reactions, phase changes, or vaporization from a spreading liquid are not incorporated; these assumptions lead to estimates of concentrations in water that are conservative.

Specifically, the Spill Assessment Model (SAM) utilized as the basis for the field calculations addresses instantaneous point source discharges into a flowing river. For field use, the primary requirement is to assess the maximum concentrations which may result from a spill at various distances from the spill location and to determine the maximum distances over which the concentration in water will exceed any specified hazard level. The objective of the field procedure is to provide a means of rapidly assessing the approximate extent of concentrations in water in excess of hazard levels.

The extent to which other hazards, such as vapor dispersion, may be associated with a spill will depend on the specific discharging substance. The field procedures described in this manual are intended for use with soluble, neutrally bouyant substances, and address only dispersion in water. For related hazards, or different types of hazards resulting from spills

of different classes of chemicals, reference sources such as the Chemical Hazard Response Information System (CHRIS) of the U.S. Coast Guard should be consulted; the methods, approach and data contained in this manual have been derived from that system. The analytical basis for the formulation of these field calculations is also documented in a separate technical report (ESL-TR-80-07).

SECTION II

CALCULATION PROCEDURE

1. INTRODUCTION

The hazard assessment calculation procedure described in this section assumes that the released chemical is instantaneously spilled into a flowing river or stream. The case of a continuous release of a chemical into water is treated only in the computerized counterpart of this procedure. A hazard assessment based on an instantaneous release provides conservative estimates of the hazard.

The calculation procedure addresses spills of chemicals which are soluble in water, liquid at ambient temperature, and not much heavier than water. The spilled chemical will both spread and mix with water at the same time. The concentration of the chemical in water will remain a hazard until dilution by mixing and diffusion sufficiently reduces the concentration.

Spills which occur in flowing streams are of particular concern because soluble chemicals, once in solution, will be confined by the banks of the stream and will remain a hazard as they flow downstream. Spills which occur in tidal areas are not usually confined, particularly during ebb tide, and rapid mixing occurs to reduce the concentration in the water. Spills which occur on calm, current-free water are not common in navigable waters.

When the mass of the spill chemical is discharged, it tends to move away from the source or spill location with a speed and direction determined by the prevailing bulk fluid velocity of the receiving water body, i.e., flowing river. The mean speed and direction of the moving chemical mass can be expected to change from the original values during its travel as

the pattern of river currents in which it is embedded changes with time. Since specification of river current variations is not practical within the objectives of the field calculation procedure, a limiting assumption is employed that the river flows with a constant cross-sectional velocity so that the center of mass of the spilled chemical moves downstream, along a longitudinal line from the spill location, at a constant rate equal to the river velocity.

As the chemical mass moves downstream, it will expand about its center owing to the action of turbulent motion. The entire mass will be carried downstream in a uniform manner, and the mass will grow in size as its edges are mixed with the water by turbulence. This growth is accompanied by a proportional decrease in concentrations within the chemical mass. At any particular time after the discharge occurs, the greatest concentration in water will occur at the location of the center of the moving chemical mass. As the chemical continues to move and spread, this maximum concentration is similarly reduced.

The degree of spreading which occurs as the chemical moves downstream depends on the river velocity, channel roughness, and the size and shape of the river channel. Faster spreading causes a more rapid decrease of the maximum concentration at the center of the moving chemical mass.

Discharges of a chemical may occur at any point in the river channel. The behavior described above of the discharged chemical in a flowing river approximates discharges which occur near the center of the river, removed from immediate influences of the river banks. For discharges which occur close to shore, the spreading of the chemical in water will quickly become

distorted by the nearer shore. Within a downstream distance equal to roughly four or five times the river width, the field calculation procedure can obtain only very approximate estimates for concentrations from spills actually occurring close to shore. At greater distances a more accurate representation is obtained since the local effects of the spill conditions become diminished as the moving chemical mass becomes distributed throughout the river channel.

2. REQUIRED DATA

The data items required to perform the field calculation procedure are:

- a. Channel Width = the average width of the river channel in feet.

For channel widths obtained in other units, conversion to units of feet is required. The calculation procedure employs a series of graphs each of which is used for a range of values of the channel width.

For any particular river channel, the average channel width can be estimated by selecting the appropriate range from the list given below. For river widths near the separation between two categories, the category containing smaller values should be selected.

- (1) Width less than 75 feet
- (2) Width 75 to 200 feet
- (3) Width 200 to 400 feet
- (4) Width 400 to 800 feet
- (5) Width 800 to 1200 feet
- (6) Width 1200 to 1800 feet

- (7) Width 1800 to 2200 feet
- (8) Width 2200 to 2800 feet
- (9) Width 2800 to 3400 feet
- (10) Width greater than 3400 feet

b. Channel Depth = the average depth of the river channel in feet.

For channel depths obtained in other units, conversion to units of feet is required. The calculation procedure employs different graphs for different river depths varying from 5 to 200 feet. However, reasonable ranges of river depth values generally differ for different river widths, and the calculation procedure uses different depth curves on each graph. The curve corresponding to the next smaller river depth should be selected.

c. Spilled Amount = the total quantity of liquid chemical discharged into the water in tons. If estimates of the quantity spilled are obtained in other units, conversion to units of tons is required.

d. Downstream Distance = the distance downstream from the location of the spill at which an estimate of the maximum concentration is to be obtained. Concentration values are tabulated for a range of downstream distances from 0.1 to 100 nautical miles. If the distance is obtained in other units, conversion to nautical miles is required (1 nautical mile = 1.15 statute miles = 6076 feet). Values of concentration factors can be obtained directly from graphs for any downstream distance between 0.1 and 100 nautical miles.

e. Hazardous Concentrations = the calculation procedure determines the maximum concentration at a given location, or the extent over which

concentrations may be expected to exceed any particular hazard level. These concentrations are expressed in units of milligrams per liter. To utilize or interpret this information, an evaluation of the concentrations at which different levels of hazard are considered to exist is necessary. These hazard levels will depend on the toxicity of the chemical, the different types of aquatic organisms of concern, spill consequences in terms of water use (e.g., industrial intake or public consumption), and other similar types of factors.

3. PROCEDURE

When a low-density chemical spill occurs on a flowing stream, two calculations can be made, depending upon the parameters given and the results desired: (1) the concentration of the chemical in the water at some distance downstream from the spill site, or (2) the distance downstream from the spill site where the chemical concentration in water is no longer considered a hazard.

The material that follows gives a guide to the procedure for field calculation and presents both a sample calculation and, immediately alongside the sample, an area where the exact hazard for the chemical and spill condition under consideration may be calculated. Calculations can then be made right on the page alongside the sample calculation. The calculation should be made in pencil, so that the results may be erased and the calculation sheet reused. The sample calculation should be studied carefully to understand how the answers are derived for the sample calculation before proceeding with the calculation of the hazards for the chemical spill under consideration.

a. Downstream Concentration at any Point

Tabulate below the information required for calculating the water pollution hazards in a flowing stream at some distance downstream from the spill site:

SAMPLE CALCULATION

Chemical: Hydrazine

Amount Spilled: 20 tons

Stream Width, W 300 feet

Stream Depth, d 30 feet

Select a distance x of interest downstream. For example x = 0.5 nautical mile downstream of the spill

CALCULATION PROCEDURE
(use pencil so it can be erased)

_____ tons
W = _____ feet
d = _____ feet
x = _____ nautical miles

Place a check mark next to the stream width which most closely matches the above tabulated stream width and determine the figure to be used in the calculation procedure. For stream widths on the border, use the smaller category.

<u>Stream Width (feet)</u>	<u>Figure to be Used</u>	<u>For Example</u>	<u>Calculation Procedure</u>
0-75	A-1	_____	_____
75-200	A-2	_____	_____
200-400	A-3	_____ ✓ _____	_____
400-800	A-4	_____	_____

800-1200	A-5	_____	_____
1200-1800	A-6	_____	_____
1800-2200	A-7	_____	_____
2200-2800	A-8	_____	_____
2800-3400	A-9	_____	_____
Greater than 3400	A-10	_____	_____

Determine the chemical concentration per ton spilled factor (C/T) from the stream depth (d), the distance downstream from the spill (x), and the figure identified above. The figures are given in Appendix A of this manual. Do not interpolate between stream depths; use the next smaller stream depth.

For the 20-ton spill of hydrazine in a stream which is 300 feet wide and 30 feet deep, use the 20-foot depth curve on Figure A-3 to determine the concentration factor (C/T) of hydrazine 0.5 nautical mile downstream of the spill.

$$\text{Concentration Factor (C/T)} = \frac{800 \text{ mg/liter}}{\text{per ton spilled}} = \text{_____ mg/liter per ton spilled}$$

Calculate the concentration at the downstream site from the factor (C/T) and the following equation:

Concentration $C = (C/T)$ (Tons spilled)

For the 20-ton spill of
hydrazine, the factor
 $C/T = 800$ mg/liter per ton
spilled and the tons spilled
 $T = 20$

$C = (800) (20) = \underline{16,000}$ mg/liter
at $x = 0.5$ nautical mile downstream

$C = (\quad) (\quad) = \underline{\hspace{2cm}}$ mg/liter

b. Downstream Extent of Hazard

To determine the distance downstream from the spill site where the chemical concentration is no longer considered a hazard, enter below the desired concentration limit in water in mg/liter for the specific chemical (a limit value of 10,000 mg/liter is used below for illustration only).

For the 20-ton hydrazine spill

Concentration
Limit = 10,000 mg/liter

 mg/liter

Calculate the limit concentration factor $(C/T)_L$ from the concentration limit and the following equation:

$$(C/T)_L = \frac{(\text{Concentration Limit})}{(\text{Tons Spilled})}$$

For the 20-ton hydrazine spill

$$(C/T)_L = \frac{(10,000)}{20} = 500 \text{ mg/liter per ton spilled} \quad \Bigg| \quad = \frac{(\quad)}{(\quad)} = \quad \text{mg/liter per ton spilled}$$

Determine the maximum downstream extent of the hazard from the factor $(C/T)_L$, the stream depth (d), and the figure identified above.

For the 20-ton hydrazine spill in a stream which is 300 feet wide and 30 feet deep, use the 20-foot depth curve on Figure A-3 and a $(C/T)_L = 500$ to determine the maximum downstream distance for the hazard concentration limit.

$$\text{Maximum hazardous distance} = 0.85 \text{ nautical mile} = \quad \text{nautical miles}$$

The above procedures are summarized in Figures 1 and 2 and are provided for quick reference.

The peak concentration at any intermediate point between the spill site and the maximum hazardous distance -- and for that matter any point beyond this maximum distance -- can be read directly off the figure used above by just following the depth curve and reading the concentrations at various

PROBLEM: Hydrazine Spill

SCENARIO: Amount Spilled;

T = 20 tons

Stream Width;

W = 300 feet

Stream Depth;

d = 30 feet

QUESTION: What is the concentration of hydrazine
0.5 nautical miles downstream?

(x = 0.5 mi)

SOLUTION:

(1) Select appropriate Figure from the Field Manual using
river width.

(2) Read concentration factor, C/T, from Figure using

x = 0.5 mi and d = 20 feet (d = 30 feet is not on Figure;

so select lower "d" value. Interpolation is not recommended).

$$\frac{C}{T} = 800 \frac{\text{mg/l}}{\text{tons spilled}}$$

(3) Solve for concentration:

$$C = (T) 800 \frac{\text{mg/l}}{\text{tons spilled}}$$

$$C = 16,000 \text{ mg/l}$$

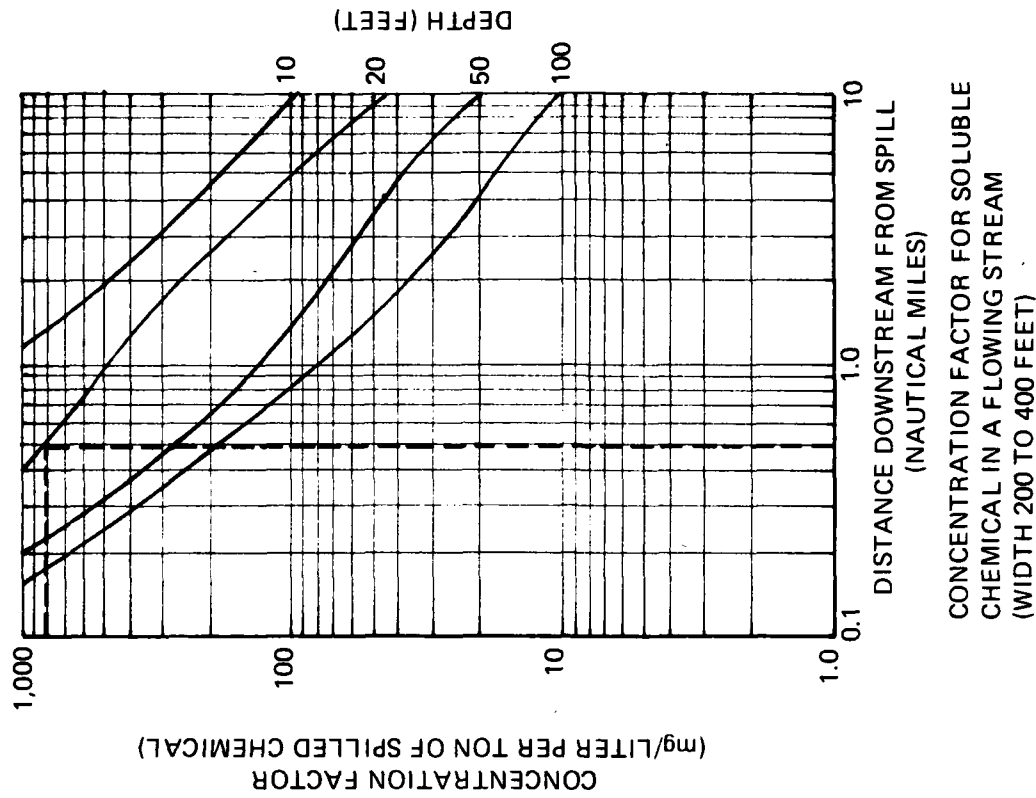


Figure 1. Concentration of Hydrazine at 0.5 Nautical Miles from Spill Site.

PROBLEM: Hydrazine Spill

SCENARIO: Amount Spilled;
T = 20 tons
Stream Width;
W = 300 feet
Stream Depth;
d = 30 feet

QUESTION: What distance downstream will the concentration in the river be no higher than 10,000 mg/l?

SOLUTION:

(1) Select appropriate Figure from the Field Manual using river width.

(2) Calculate the limit concentration factor, $(C/T)_l$.

$$(C/T)_l = \frac{\text{Concentration limit (mg/l)}}{\text{tons spilled}}$$

$$(C/T)_l = \frac{10,000 \text{ mg/l}}{20 \text{ tons spilled}} = 500 \frac{\text{mg/l}}{\text{tons spilled}}$$

(3) Read distance from the Figure

$$x = 0.85 \text{ nautical miles}$$

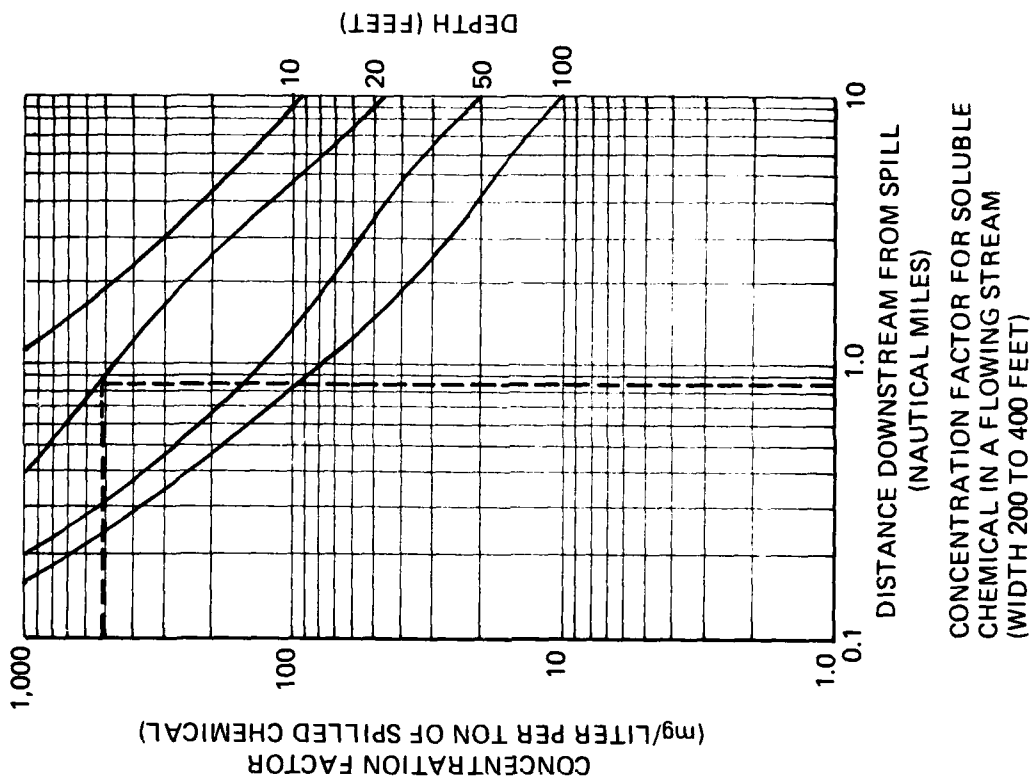


Figure 2. Distance Downstream Where Concentrations are not Higher than 10,000 mg/l.

downstream distances. These concentrations are based on "per ton of chemical spilled," and therefore must be multiplied by the number of tons spilled to give the actual peak concentrations. In addition, the time that the peak concentration of the chemical will reach a given point downstream is simply that distance divided by the stream velocity. However, some of the chemical may reach a given point downstream well before the peak concentration does.

Appendix A of this manual contains the necessary graphs, Figures A-1 to A-10, for the field calculation procedure. Section IV of this manual describes a series of data tables, from which the graphs were prepared, which may be similarly used. The data tables are contained in Appendix B of this manual.

SECTION III

USE OF GRAPHS FOR CALCULATION PROCEDURE

The 10 graphs presented in Appendix A are used with a simple calculation procedure to determine the maximum downstream concentration in water of a soluble chemical which has spilled into a flowing stream.

The graphs give the concentration factor as a function of distance downstream from the spill site and the depth of the stream for various width ranges of the stream.

For actual estimated river depths between those values displayed, interpolation may be used for approximate results, or the next smaller stream depth curve selected for conservative results.

Each graph corresponds to a range of values for the stream width. Select the appropriate graph for the width of the stream into which the spill has occurred. For stream widths close to the limit of a range, select the graph for the smaller category for conservative results. The graphs and corresponding width intervals are:

<u>Stream Width (feet)</u>	<u>Figure to be Used</u>
0-75	A-1
75-200	A-2
200-400	A-3
400-800	A-4
800-1200	A-5
1200-1800	A-6

<u>Stream Width (feet)</u>	<u>Figure to be Used</u>
1800-2200	A-7
2200-2800	A-8
2800-3400	A-9
Greater than 3400	A-10

Quantities used or determined from these graphs are measured in units
of:

Stream width in feet

Stream depth in feet

Distance downstream from spill site in nautical miles

Concentration factor in mg/liter per ton of spilled chemical.

SECTION IV
USE OF DATA TABLES

The 10 tables presented in Appendix B contain values of the concentration factor tabulated for a range of values of stream width, stream depth, and distance downstream from the spill location. Data contained in these tables were selected to prepare the graphs for the manual calculation procedure given in Appendix A. In some cases the tables also contain additional data points which could be useful for unusual channel geometries or as interpolation aids.

The tables give the concentration factor as a function of distance downstream from the spill site and the depth of the stream for various values of stream width.

For actual estimated river depths between those values displayed, interpolation may be used for approximate results, or the next smaller stream depth column may be selected for conservative results.

Each table corresponds to a range of values for the stream width. Select the appropriate table for the width of the stream into which the spill has occurred. For stream widths close to the limit of a range, select the table for the smaller category for conservative results. The tables and corresponding width intervals are:

<u>Stream Width (feet)</u>	<u>Table to be Used</u>
0-75	B-1
75-200	B-2
200-400	B-3

<u>Stream Width (feet)</u>	<u>Table to be Used</u>
400-800	B-4
800-1200	B-5
1200-1800	B-6
1800-2200	B-7
2200-2800	B-8
2800-3400	B-9
Greater than 3400	B-10

Quantities used or determined from these tables are measured in units
of:

Stream width in feet

Stream depth in feet

Distance downstream from spill site in nautical miles

Concentration factor in mg/liter per ton of spilled chemical.

SECTION V

ANALYTICAL BACKGROUND

1. INTRODUCTION

The graphs and tables contained in this field manual are based on an analysis of the dispersion of a spilled chemical into a flowing river. Details of the formulation of the equations governing the concentration behavior are described in a separate report (ESL-TR-80-07). In this section of this report, the resulting general equations are assumed to be given, and the computations then required to prepare the graphs and tables for field use are described. Maximum concentrations are obtained by assuming instantaneous instead of continuous release conditions.

Dispersion of a spilled chemical into a non-tidal river can be viewed as equivalent to dispersion in still water, subject to the influence of two additional factors: the bulk fluid motion of the river current, and the constraints imposed by the banks and bottom of the river channel. For a spill into still water, the movement of the spilled chemical occurs in all directions away from the center of mass of the spilled chemical. The center of mass remains stationary at the spill location, and the maximum or peak concentration at any time after the start of the spill occurs at the spill location.

For a river setting, the river channel is assumed to be rectangular, of uniform cross-section, and a rectangular coordinate system is taken with the origin at the center of the channel on the water surface where x gives downstream distance from the spill location, y gives the

cross-channel position, and positive z gives depth so as to form a right-handed coordinate system. Considering only the influence of the river motion, the flow is assumed to be uniform across the cross-section of the river, in the direction of the positive x axis, and the velocity is given as u . The center of mass of the dispersing chemical is transported downstream by the bulk fluid motion, moving with a velocity u so that the distance moved in time t is given by ut . Relative to the center of mass of the spilled substance, the coordinates become stationary, and the type of dispersion behavior of the still water case applies. That is, at any time t , after the start of the spill, the maximum concentration for any location in the river channel occurs at the location of the center of mass of the spilled chemical.

About the center of mass of the spilled substance, the initial concentration distributions are Gaussian so that for times greater than zero, the concentrations decrease with distance from the center of mass, but have some value at all distances. However, at very large distances, the concentrations are very small. Conservation of mass can be applied to define a region of the water body, or "volume," centered about the center of mass of the spilled substance, within which some fixed amount, for example 95 percent of the total dispersing mass is initially contained.

As the elapsed time from the start of the spill increases, the "volume" containing the dispersing chemical both moves downstream with a velocity u and grows in size. The growth continues until either a channel bank or the river bottom is encountered. Further growth in that direction is impeded, and the nature of the concentration distribution is modified. It is assumed that these boundaries are impenetrable, thus the amount of substance

contained in the portion of the volume that would have grown beyond the channel banks or bottom is "reflected" back into the river channel. The method of obtaining the additional contributions to the concentration in the river channel of the reflected amount of substance involves summing concentration distributions from additional virtual spill sources or "images" located outside the boundaries of the river channel.

The resulting equation used to describe this behavior is given as:

$$c(x,y,z,t) = \frac{2M}{(4\pi t)^{3/2} \sqrt{e_x e_y e_z}} \cdot e^{-kt} \cdot e^{-\frac{(x-ut)^2}{4e_x t}} \cdot \left[e^{-\frac{(y-a)^2}{4e_y t}} + e^{-\frac{(y+a+w)^2}{4e_y t}} + e^{-\frac{(y-w+a)^2}{4e_y t}} \right] \cdot \left[e^{-\frac{z^2}{4e_z t}} + e^{-\frac{(z-2d)^2}{4e_z t}} + e^{-\frac{(z+2d)^2}{4e_z t}} \right]$$

where:

- $c(x,y,z,t)$ = concentration at a location x, y, z , and at time t after start of spill, gm/cm^3
- x,y,z = coordinates of point in river channel at which concentration is obtained, cm
- t = elapsed time from start of spill, sec
- M = quantity of liquid substance released, gms
- k = decay coefficient, sec^{-1}

u = stream velocity, cm/sec
 e_x, e_y, e_z = turbulent dispersion coefficients, cm^2/sec
 w = mean river channel width, cm
 d = mean river channel depth, cm
 a = spill offset; location of spill across channel width relative to river centerline, cm

When spilled into a stream or river, the behavior of a chemical depends on a number of factors. These include the physical and chemical properties of the chemical, the flow conditions in the river, and the location and nature of the release. If the area of the source of the spill is small in relation to the size of the river, the dispersion of the chemical will be in all directions. In this phase, the dispersion is three dimensional, and the concentrations obtained from the above equation depend on the coordinates (x,y,z) of the location of interest. It can be seen that at any time t , during the initial stages of dispersion, the maximum concentration occurs at the surface ($z=0$), at a cross channel location equal to the spill offset ($y=a$) if the offset, a , is less than the half-width of the river, and at a downstream distance ($x=ut$) corresponding to the bulk motion of the center of mass of the spilled chemical.

Near the spill location, the concentrations are significantly dependent on the location of the spill, manner of release, and a range of other local effects. As the distance from the spill location increases, the concentrations obtained from this equation tend to become evenly distributed over the cross-section of the river, and localized effects of the spill conditions are reduced.

Since the cross-sectional variations of concentration are significant during this early stage of spreading, descriptions of the shape of the river cross-section and the river velocity distribution across the cross-section are necessary. The concentration equation assumes a rectangular channel cross-section of constant width and depth, and a constant river velocity, uniform over the river cross-section.

As the dispersion chemical mass moves downstream, the maximum concentration occurs at the location of the moving center of mass, which is translated in the longitudinal direction of river motion as long as the confining effects of the river channel banks and bottom are minimal. At longer distances from the spill location, depending on the cross-channel position of the spill location, reflections of the dispersing chemical will cause the location of maximum concentration to drift away from this axis. However, if the spill location is assumed to be at the center of the river, symmetry gives the result that the location of maximum concentration continues to occur at the centerline.

Graphs and tables of maximum concentration are then obtained from the general equation using coordinate values $x = ut$, $y = 0$, $z = 0$, and the spill location is taken to be at the center of the river, using $a=0$. Since the general concentration equation includes, to within a first order approximation, terms to account for the reflection of dispersing chemical by the channel banks and boundaries, this equation is used for all distances from the spill location. For large distances from the spill location, an alternate formulation of the concentration equation can be obtained based on the assumption that the spreading chemical has become uniformly distributed over the cross-section of

the river channel. This approach is briefly described in a following section, however, since terms accounting for the reflections from the river channel banks and boundaries were incorporated in the general concentration equation given above, adaptation of this alternate formulation for field use was not necessary.

2. EVALUATION

a. Simplification of Equation

As discussed above, the graphs and tables of maximum concentration for field use were obtained by setting the coordinates $y=z=0$, the spill offset, a , to zero, and $x=ut$. Since the maximum concentration at a location x occurs at a time equal to $\frac{x}{u}$, substitution of these coordinates gives an expression for the maximum concentration directly as a function of x and not t . In addition, further substitution shows that the velocity terms cancel, so that the maximum concentration as a function of x is independent of the river velocity u .

The effect of chemical decay or degradation in the aquatic environment is included in the general concentration equation by the term e^{-kt} which models an exponential decay process. The decay results in a reduction of the total quantity of dispersing chemical, which in turn directly reduces the resulting estimates of concentrations. Since in many cases products of decay or decomposition are also hazardous, conservative concentration estimates are obtained by taking $k=0$.

Substitution of these values gives the equation for the maximum concentration as:

$$c(x) = \frac{2M}{(4\pi \frac{x}{u})^{3/2} \sqrt{e_x e_y e_z}} \cdot \left[1 + 2 e^{-\frac{w^2 u}{4 e_y x}} \right] \cdot \left[1 + 2 e^{-\frac{d^2 u}{e_z x}} \right]$$

where $c(x)$ gives the maximum concentration at a location x as a function of:

x , downstream distance from the spill location

w , mean river width

d , mean river depth

M , total quantity of spilled chemical, and

e_x, e_y, e_z , dispersion coefficients.

The velocity u appearing in the equation is removed when empirical expressions for the dispersion coefficients are substituted.

b. Evaluation of Dispersion Coefficients

The concentration equation is written above in Centigrade-Gram-Second (CGS) units, and the appropriate equations for the turbulent dispersion coefficients are given by:

$$e_z = 0.067 U^* R_h$$

$$e_x = 0.1 e_z$$

$$e_y = 0.23 U^* R_h \quad \text{if } \frac{w}{d} < 100$$

$$e_y = e_x \quad \text{if } \frac{w}{d} > 100$$

The ratio of river width to depth is used to obtain different expressions for the coefficient e_y for narrow rivers ($\frac{w}{d} < 100$) or wide rivers ($\frac{w}{d} > 100$).

The hydraulic radius, R_h , is given by the cross sectional area divided by the wetted perimeter:

$$R_h = \frac{w \cdot d}{2 d + w}$$

The shear velocity, U^* , in units of cm/sec is given by:

$$U^* = 6.7305 n \cdot \frac{u}{R_h^{1/6}}$$

where n is the Manning roughness coefficient. In this formulation for field application, a coefficient value of $n = 0.03$ is assumed, and the dispersion coefficients are obtained as functions of w , d , and u .

Substitution gives the values of the dispersion coefficients in units of $\text{cm}^2/\text{second}$, for $n = 0.03$, as:

$$e_x = (1.353 \times 10^{-3}) u \cdot R_h^{5/6}$$

$$e_z = 10 \cdot e_x$$

$$e_y = (4.644 \times 10^{-2}) u \cdot R_h^{5/6} \quad \text{for } \frac{w}{d} < 100$$

or

$$e_y = e_x \quad \text{for } \frac{w}{d} > 100$$

c. Selection of Parameters

Since by substitution the velocity terms, u , cancel, the maximum concentration for the particular assumptions employed reduces to a function only of river width (w), river depth (d), downstream distance from the spill location (x), and total quantity spilled (M).

Since the maximum concentration at a location x is directly proportional to the total quantity spilled, the graphs for field use are generated to obtain the ratio $\frac{c(x)}{M}$, or concentration per unit quantity spilled, as a concentration factor. In application, the estimate of actual concentration is obtained by multiplying the total quantity of substance by the appropriate value of the factor. To express spill quantities in units of tons, the concentration factor is obtained by evaluating the concentrations resulting from a release of 1 ton of substance. Converting to CGS units for use in the concentration equation as written above gives:

$$M = (1.0) (2000) (454) \text{ in grams}$$

A range of river width and depth values, in units of feet were selected to describe most river channel dimensions of practical concern, and concentrations were computed for each combination of values. All resulting computed values are given in the tables in Appendix B. However, the graphs in Appendix A show only the most realistic of these combinations. Values selected for river depths and widths were:

$$\text{depth} = 5, 10, 20, 30, 50, 100, 200 \text{ (feet)}$$

$$\text{width} = 50, 100, 200, 400, 800, 1200, 1800, 2200, 2800, 3500 \text{ (feet)}$$

For use with the concentration equation in CGS units these were converted to give:

$$d = (\text{depth in feet}) (12) (2.54) \text{ in cm}$$

$$w = (\text{width in feet}) (12) (2.54) \text{ in cm}$$

Concentrations were then obtained for plotting over downstream distances in units of nautical miles at points selected as:

$$\begin{aligned} \text{distance} = & 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 2.0, \\ & 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 20.0, 30.0, \\ & 40.0, 50.0, 60.0, 70.0, 80.0, 90.0, 100.0 \end{aligned}$$

Conversion to CGS units used:

$$x = (\text{distance in n.m.}) (2.54) (12) (5280) (1.15155) \text{ in cm}$$

The concentration equation gives the result in units of gm/cm^3 ; tabulation in units of mg/liter (per ton spilled) was obtained from:

$$\text{concentration} = (c \text{ in gm/cm}^3) \times 10^6, \text{ mg/liter}$$

3. ALTERNATE FORMULATION

The spreading of a spilled chemical is assumed to occur, in general, in three dimensions until further horizontal or vertical movement is constrained by the channel banks or bottom. For most river channels of practical interest, a spilled chemical will first become more or less uniformly distributed over the depth of the river, then further spreading horizontally occurs to produce a uniform distribution across the width of the river channel. The order of time for horizontal spreading to produce measurable concentrations at the river banks is given by:

$$t_c = \frac{b^2}{e_y}$$

where $b = \frac{w}{2}$ is the half-width of the river channel.

The initial period, t_1 , is defined as the duration over which three-dimensional spreading can be assumed to occur, and is given by:

$$t_i = 0.3 t_c = 0.3 \frac{b^2}{e_y}$$

Since the coordinate of the observation point of interest is taken at the center of mass of the spilled chemical, this criteria can be expressed in terms of an initial distance from the spill location, x_i , which is given as:

$$x_i = u \cdot t_i = 0.3 u \frac{b^2}{e_y}$$

For distances x less than x_i , the effect of the channel banks in confining the distribution of the spilled chemical is small, and the equations for three dimensional spreading are used. For distances greater than x_i , the effects of the channel banks become more pronounced, and eventually the spilled chemical becomes uniformly distributed across the cross-section of the river channel. Further spreading occurs only longitudinally.

Since the three dimensional equation utilized to obtain the concentrations includes terms which account for the effects of the channel banks and bottom in confining the spreading, to a first order approximation, this equation has been used for all values of the distance from the spill location.

If however it is assumed that the chemical is uniformly mixed across the river channel cross-section, then the appropriate concentration equation for one-dimensional spreading is given by:

$$c(x,t) = \frac{M}{A\sqrt{4\pi Et}} e^{-\frac{(x-ut)^2}{4Et}} e^{-kt}$$

where c , M , t , x , u , and k are as defined previously. The cross-sectional area of the river channel is A , obtained from

$$A = w \cdot d \text{ in cm}^2$$

and E is an effective longitudinal dispersion coefficient, in units of $\text{cm}^2/\text{second}$. The coefficient E represents not only the dispersion e_x but also the dispersion of the chemical due to the differential velocities and concentrations across the river channel. Since the formulation of the effective longitudinal dispersion coefficient E is different from e_x , and the one-dimensional equation is based on an assumption that complete uniform cross-sectional mixing has occurred, the concentrations obtained from the three-dimensional equation and the one-dimensional equation will generally be different, giving rise to a discontinuity between the concentrations computed from each equation. Since the basic assumptions underlying each equation differ, it is not necessarily advisable to artificially remove the discontinuity if the three dimensional and one-dimensional equations are applied to the same spill scenario.

Substituting for t from $x=ut$, and using $k=0$ and $A=w \cdot d$, gives the concentration equation in a reduced form as:

$$c(x) = \frac{M}{wd \sqrt{4 \pi E \frac{x}{u}}}$$

The longitudinal dispersion coefficient, E , is computed using the shear velocity and hydraulic radius from:

$$E = \alpha U^* R_h \text{ in cm}^2/\text{second}$$

where the constant α depends on the ratio of the river width to depth:

$$\alpha = 20.22 \quad \text{for } \frac{w}{d} < 100$$

$$\alpha = 225. \quad \text{for } \frac{w}{d} > 100$$

It should be noted that the value of e_y used to obtain the initial time, t_i , or distance, x_i , is also similarly dependent on the width to depth ratio.

Since the dispersion coefficient, E , depends on the river velocity, u , in the same way as e_x , e_y , and e_z , it can be seen that the resulting concentration, $c(x)$, is independent of u . For a particular river channel cross section, this gives a concentration profile along the downstream direction that is inversely proportional to the square root of the distance from the spill location.

4. LIMITATIONS AND MAJOR ASSUMPTIONS

In addition to the basic assumptions underlying the derivation and formulation of the concentration equation utilized to produce the graphs and tables for field use, reviewed in following paragraphs, the analytical expression contains a singularity at the spill location. That is, the initial value of the concentration at the spill location is infinite, and for very small distances from the spill location, the peak concentration at the center of the moving spill mass may, as a result, exceed the density of the spilled chemical. For this reason, caution should be exercised to interpret estimated concentrations at locations very close to the spill location.

Because of the complexity of the chemical spill process, the uncertainties and variabilities associated with spill conditions and the nature of the environment in the vicinity of the spill, and the difficulties inherent in describing these phenomena, the analysis and implementation of the water dispersion model, from which the field calculation procedures were derived, has necessarily been based on numerous assumptions. Further assumptions were then introduced to enable simplification of the calculations for field use. The degree of sophistication attempted was carefully considered, and assumptions or limitations introduced to enable the model to be applied to a class of non-chemical specific discharges in a range of environmental settings. Also, the model is intended for use in real or threatened emergency spill situations, in addition to routine assessments for contingency planning, and thus the input data required is restricted to that information that can be readily observed, estimated or assumed

from on-scene observations or reports; use of extensive, detailed site specific data is precluded. Major assumptions and/or limitations that are incorporated in the model are summarized for review in the following paragraphs.

Heat sources and heat sinks are neglected and the assumption is made that the initial temperature of the spilled chemical and the receiving water body are nearly equal. Any initial unequal temperatures would ultimately come to equilibrium at a temperature very nearly equal to the temperature of the water into which the spill occurs because of the comparatively large thermal capacity of a receiving water body into which a large scale spill may occur. During the initial stages of dispersion, the difference in the temperatures of the spilled chemical and the receiving water could effect the rate of dispersion. The significance of this assumption depends on the type of chemical, and relative temperature ranges at which these are transported.

Temperature differences may also give rise to buoyancy effects. Studies of these effects have been reported in the literature, many of these dealing with thermal discharges from power plants or waste water discharges through submerged outlets or distributed outfalls. In these cases, the discharge is lighter than the receiving water. The movement of the discharge as it rises creates secondary induced turbulent currents, and the rate of dispersion and manner in which it takes place are effected. The water dispersion model described in this report assumes that the spill occurs onto the surface of the waterway, and the effect of buoyancy has not been incorporated. Thus the model strictly is most appropriate for those

liquids that are neither significantly lighter nor denser than the receiving water. The model may also be applied for the dispersion of solid particles, if these are neutrally buoyant or if the settling times are large in comparison to the dispersion.

Chemical degradation in the aquatic environment has been modeled by a first order rate constant process, but degradation is ignored for field calculations. Additional effects of chemical reactions or phase changes during dispersion have not been incorporated. Phenomena associated with chemical reactions, and also neglected, include resulting dispersion of the products of reaction, and thermal effects from the heat of reaction. The most significant model assumption may be that no vapor is liberated, and, that other than a first order decay, the entire mass of spilled chemical is dispersed. The model assumes the chemical is fully soluble in water (miscible in all proportions), and that all the discharged chemical goes into solution with water. A separate model has been developed independently to estimate vaporization rates; however, the resulting reduction of the mass dispersing in water has not been incorporated. This assumption leads to estimates of concentrations in water that are conservative.

Stratification of the receiving water body, and the interaction with density or buoyancy effects have not been included, although the receiving water body is considered to be non-isotropic, with different but constant dispersion coefficients along each axis.

Strictly, the model applies to spills of large quantities that occur under assumed instantaneous or continuous discharge conditions; field

calculation procedures are developed only for instantaneous releases. For continuous discharges, the rate at which the chemical is released is assumed to be constant. An analysis of the continuous release model has formulated an approach in which a variable mass release rate can be modeled. However, as implemented, the model is limited to a constant release rate since for the purpose of expected use it was assumed that inadequate information would be available to accurately characterize a variable rate.

River channels are modeled as having a constant rectangular cross section, and a constant cross-sectional average river velocity has been assumed for non-tidal rivers. For tidal rivers, the tidal effect has been modeled by a sinusoidal velocity imposed on the non-tidal component. Velocity variations caused by winds, storms, local channel obstructions, and similar effects have not been included. The boundaries (banks and channel bottom) of the river channel have been assumed to be impenetrable to the dispersing mass, and only first order image sources have been included to model the effect of confined dispersion.

In regions near to the source for a continuous discharge into a river, the additional longitudinal travel due to longitudinal dispersion is neglected with respect to the bulk motion of the dispersing mass in the direction of river travel. This assumption is strictly applicable to rivers in which the rate of longitudinal diffusion is small with respect to the movement with the river velocity; however, all but the most slowly flowing rivers will give reasonably good agreement with this assumption.

At distances far from the location of a spill into a non-tidal river, a simplifying assumption is made that the dispersing mass reaches a uniform

cross-sectional distribution, and further dispersion occurs in a one-dimensional manner in the direction of river flow. While the assumption is reasonably consistent with the expected behavior of the mass at large distances from the spill, and introduces some simplicity in the model formulation, the resulting difference in the modeling equations may cause a discontinuity in concentration estimates between the "near" and "far" regions. Since the model incorporates, to a first order, the boundary effects in the region near the spill site, concentrations reached at long distances from the spill location should be expected to approximate those obtained by one-dimensional analysis, and as a result the one-dimensional analysis is not essential. The model does not currently include provision for automatically forcing a match between these near and far field equations, and the results obtained should instead be interpreted in terms of the type of dispersion being modeled.

Although some of these assumptions and limitations have greater effect than others, it is generally concluded that the assumptions lead to a simplified, but reasonably realistic, model with which estimates of concentration distributions can be obtained on the same order of accuracy as the accuracy to which the required model inputs are available.

REFERENCES

1. Hazard Assessment Handbook, CG-446-3, U.S. Coast Guard, January, 1974, Unclassified.
2. Potts, R. G., et. al., "Advanced Spill Model," Arthur D. Little, Inc., Report ESL-TR-80-07 to U.S. Air Force, Headquarters Air Force Engineering and Service Center, Tyndall AFB, Florida, February 1980, Unclassified.

APPENDIX A

GRAPHS FOR CALCULATION PROCEDURE

The following 10 graphs are used with a simple calculation procedure described in Section II to determine the maximum downstream concentration in water of a soluble chemical which has spilled into a flowing stream. Each graph corresponds to a range of values for the stream width. Select the appropriate graph for the width of the stream into which the spill has occurred. For stream widths close to the limit of a range, select the graph for the smaller category for conservative results. The graphs and corresponding width intervals are:

<u>Stream Width (feet)</u>	<u>Figure to be Used</u>
0-75	A-1
75-200	A-2
200-400	A-3
400-800	A-4
800-1200	A-5
1200-1800	A-6
1800-2200	A-7
2200-2800	A-8
2800-3400	A-9
Greater than 3400	A-10

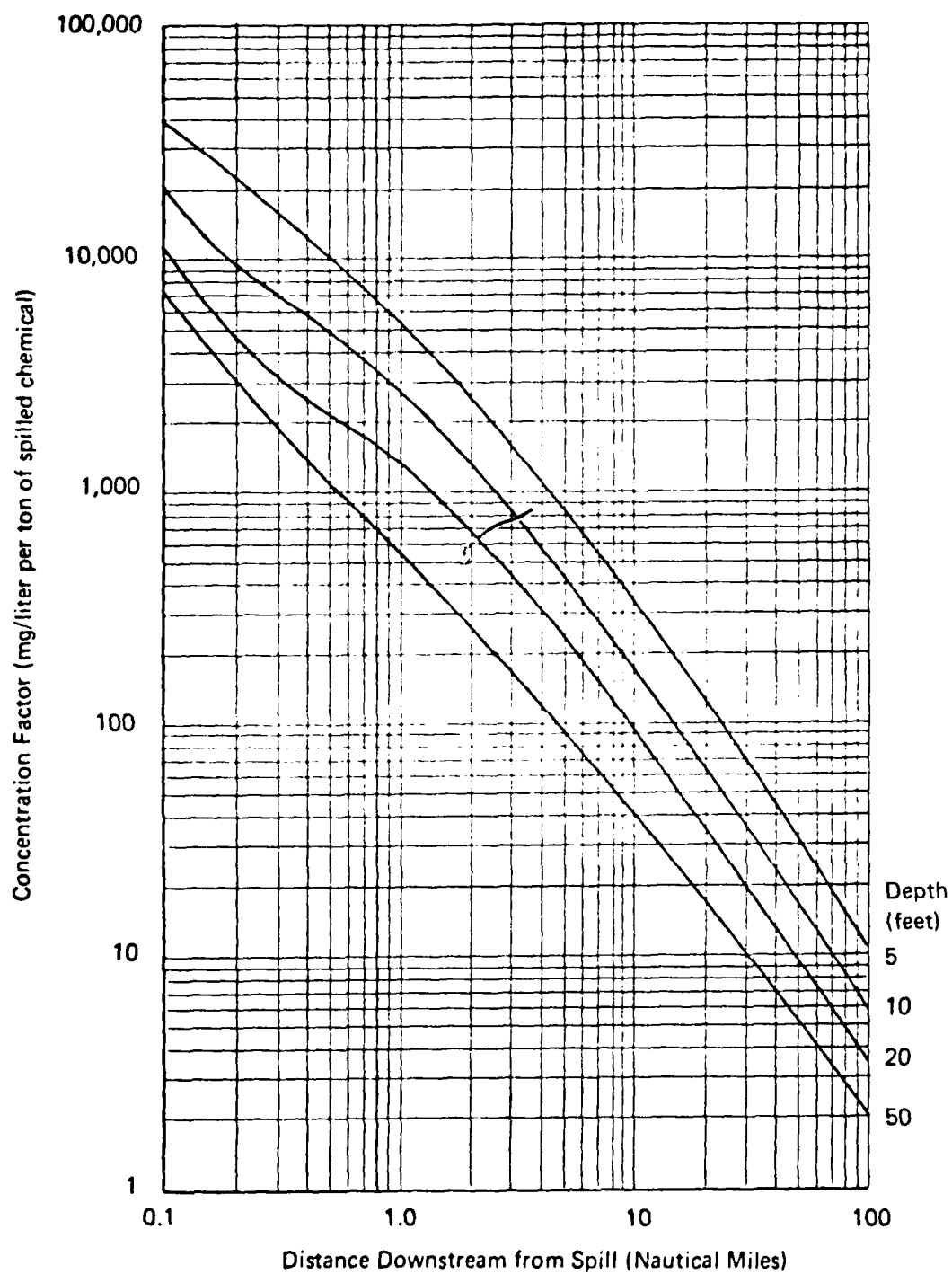


Figure A-1 Concentration Factor for Soluble Chemical in a Flowing Stream (Width Less than 75 Feet)

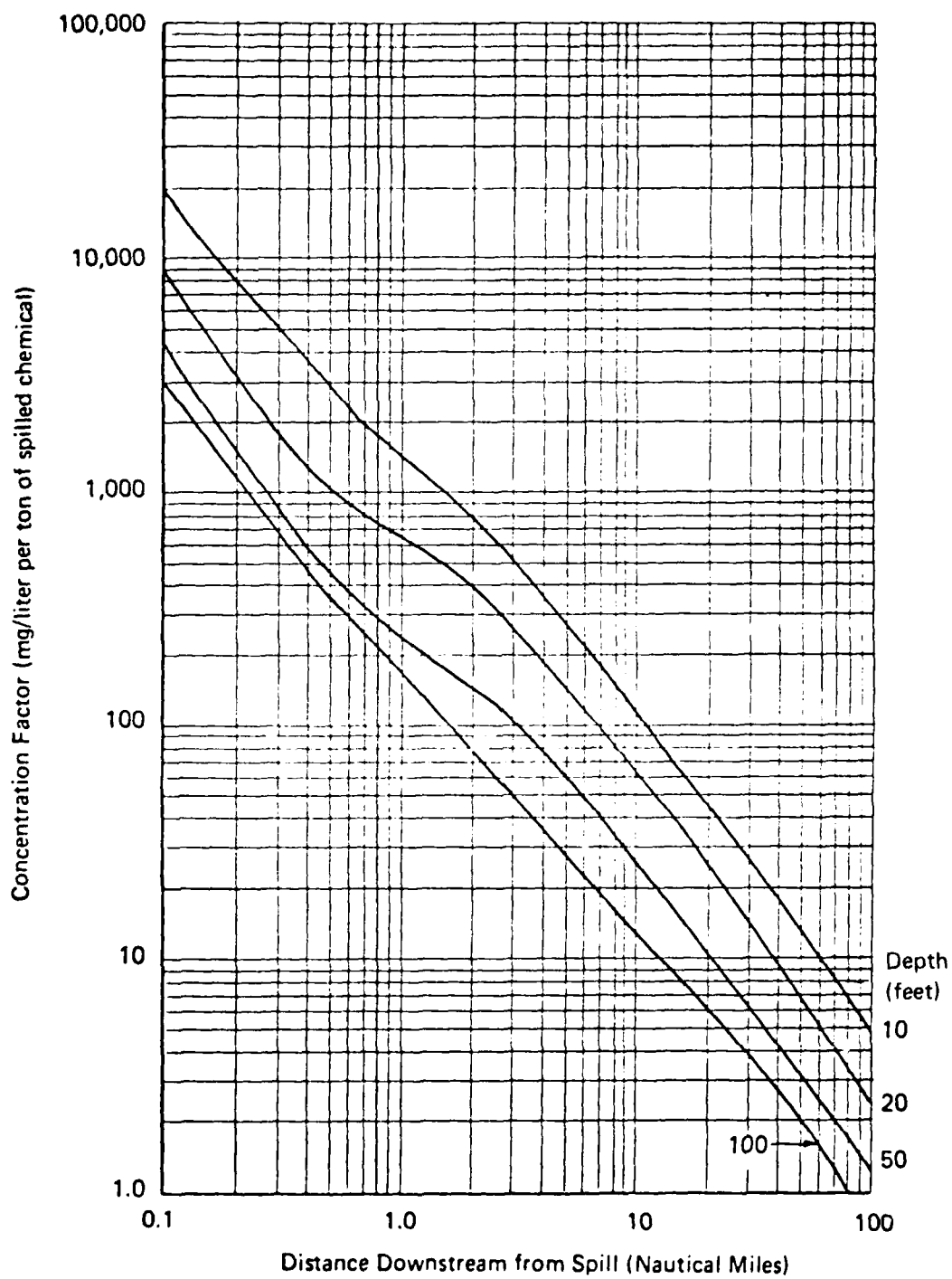


Figure A-2 Concentration Factor for Soluble Chemical in a Flowing Stream (Width 75 to 200 Feet)

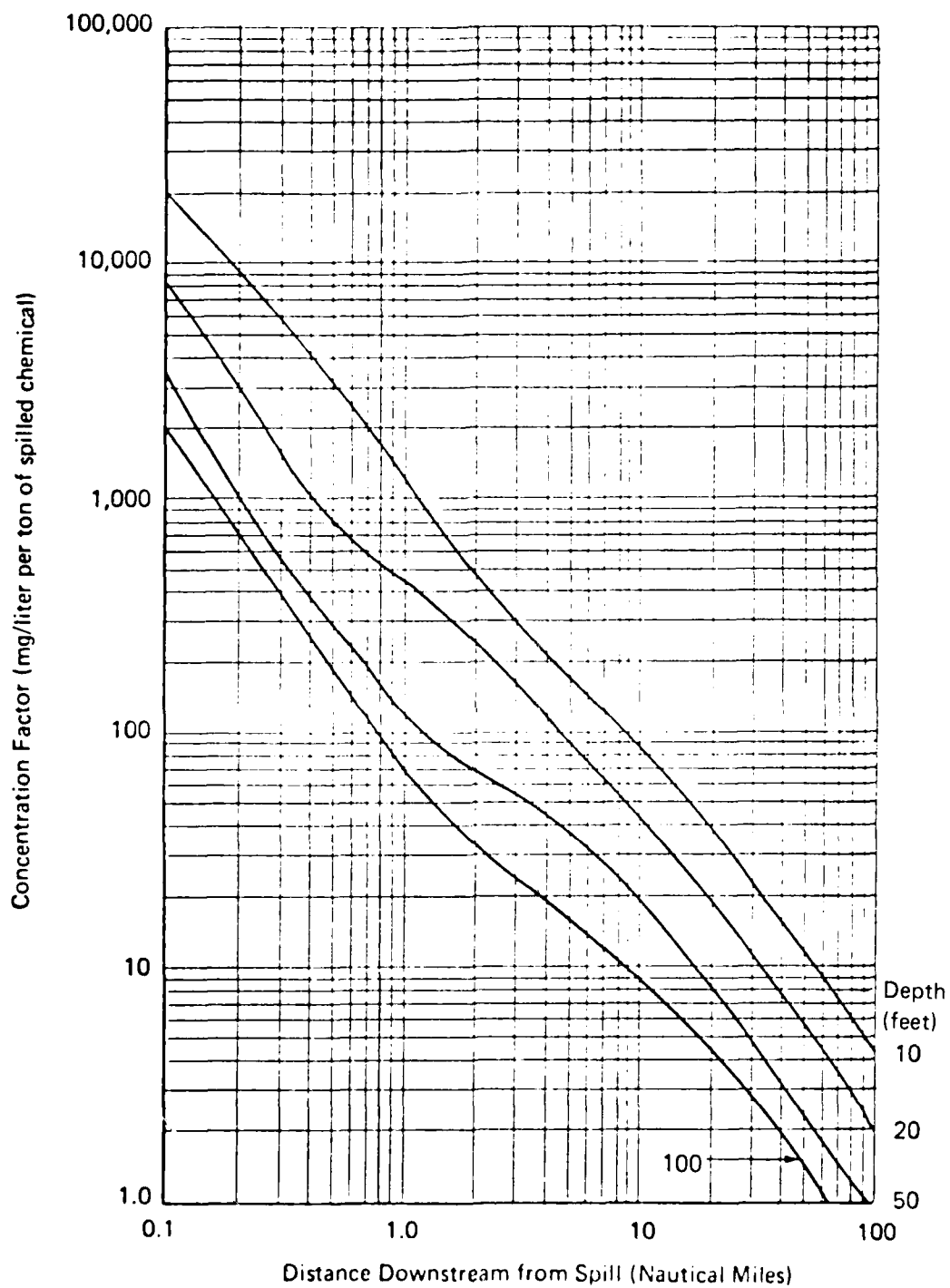


Figure A-3 Concentration Factor for Soluble Chemical in a Flowing Stream (Width 200 to 400 Feet)

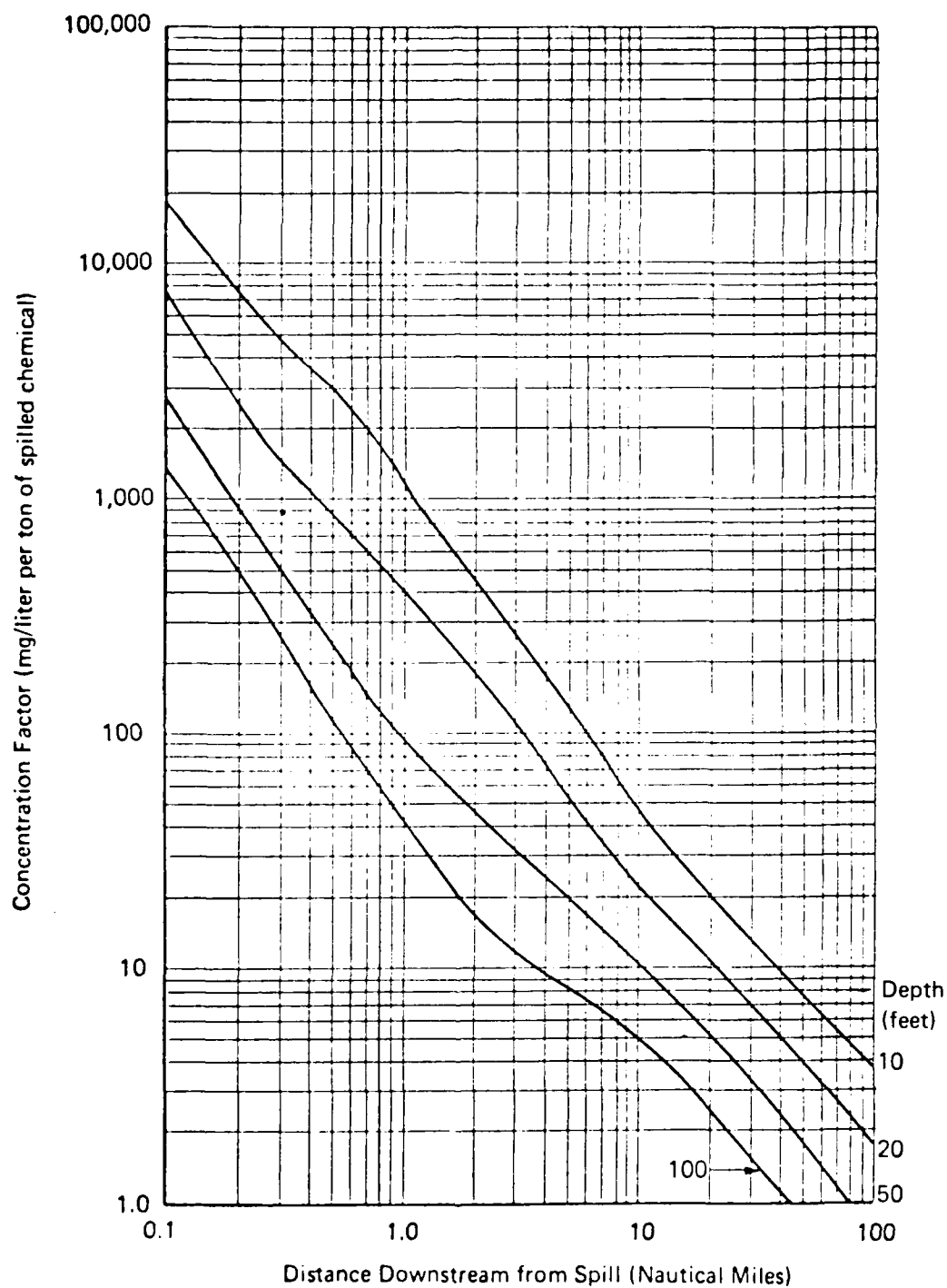


Figure A-4 Concentration Factor for Soluble Chemical in a Flowing Stream
(Width 400 to 800 Feet)

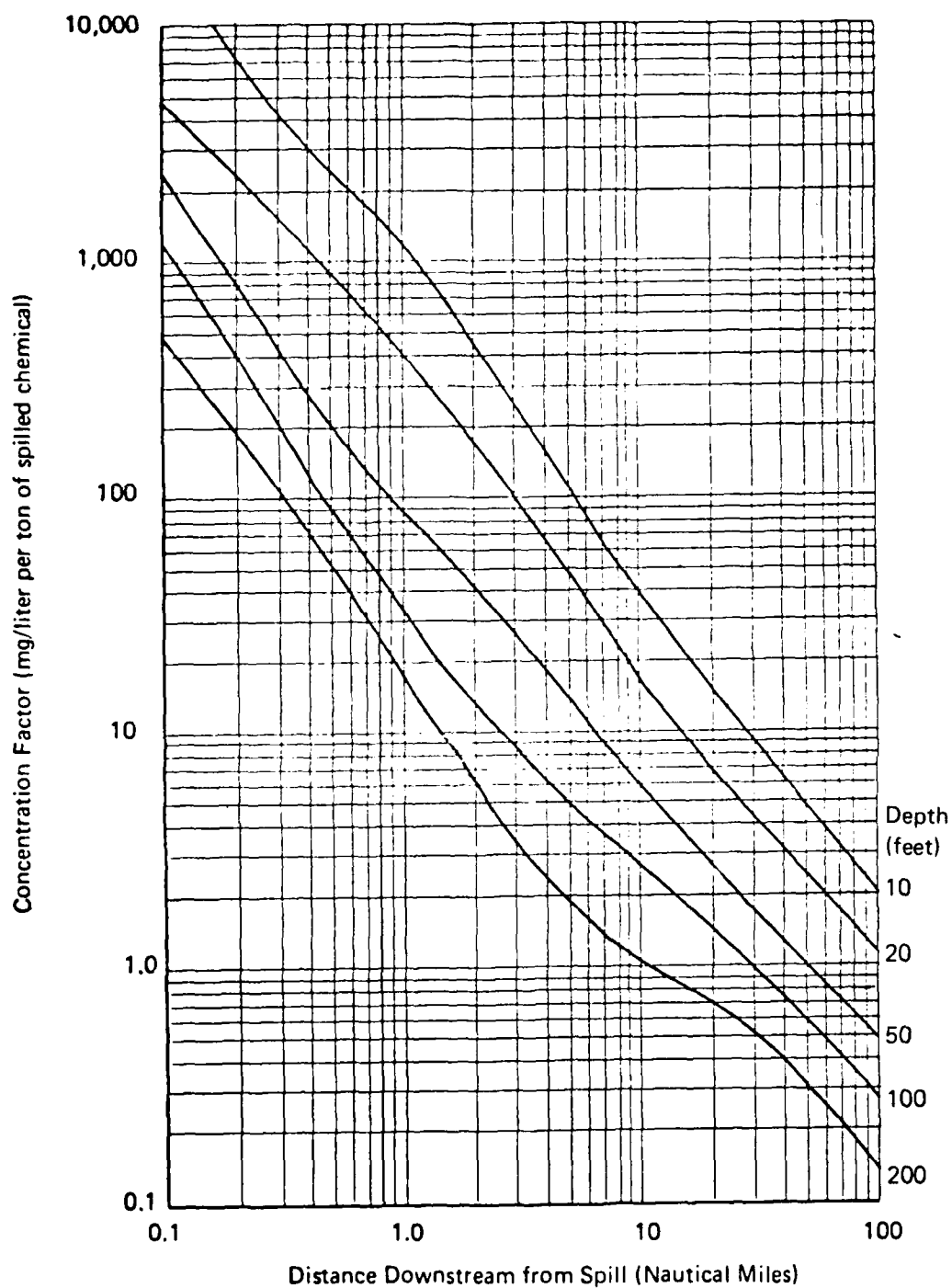


Figure A-5 Concentration Factor for Soluble Chemical in a Flowing Stream
(Width 800 to 1200 Feet)

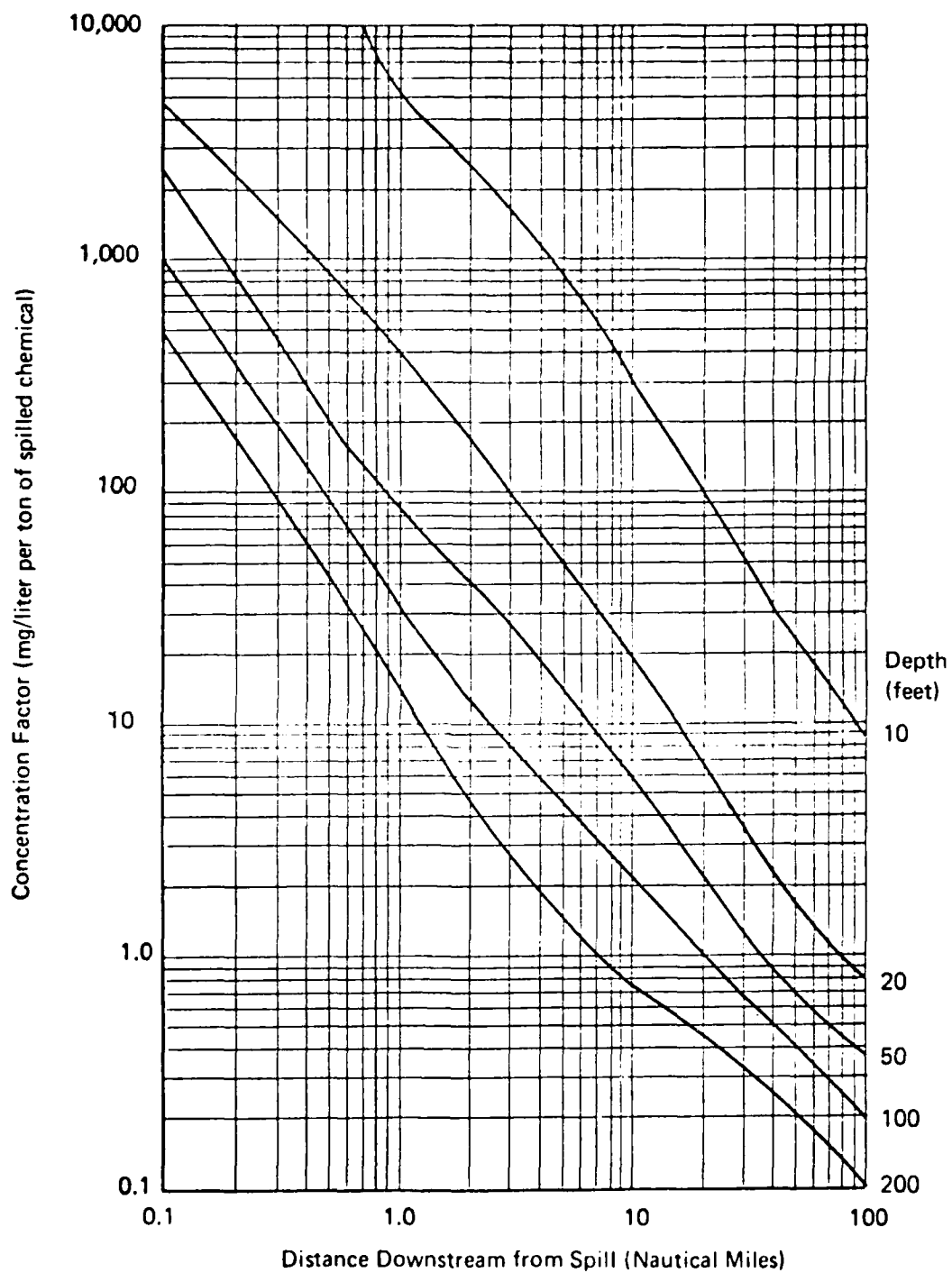


Figure A-6 Concentration Factor for Soluble Chemical in a Flowing Stream
(Width 1200 to 1800 Feet)

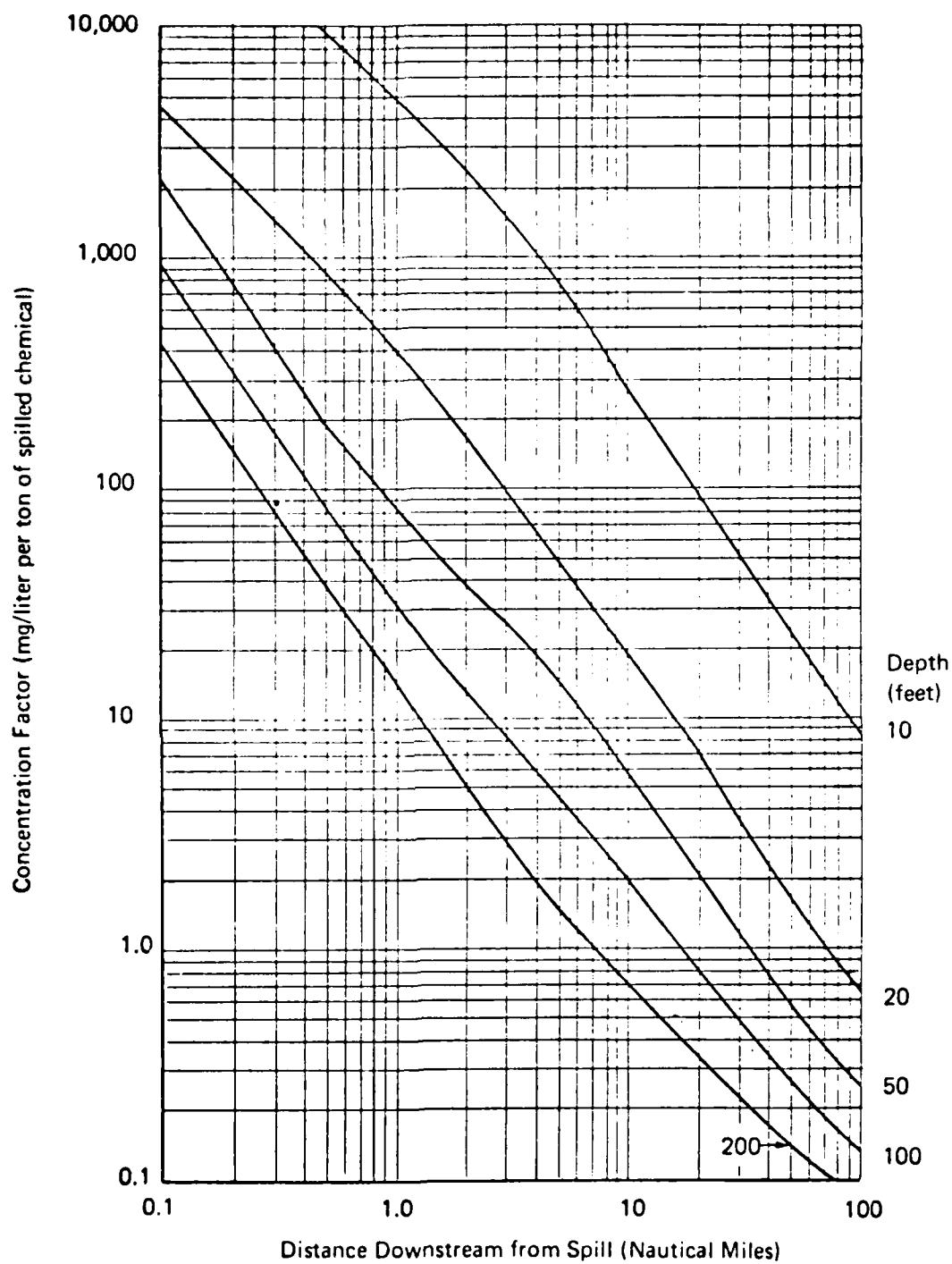


Figure A-7 Concentration Factor for Soluble Chemical in a Flowing Stream
(Width 1800 to 2200 Feet)

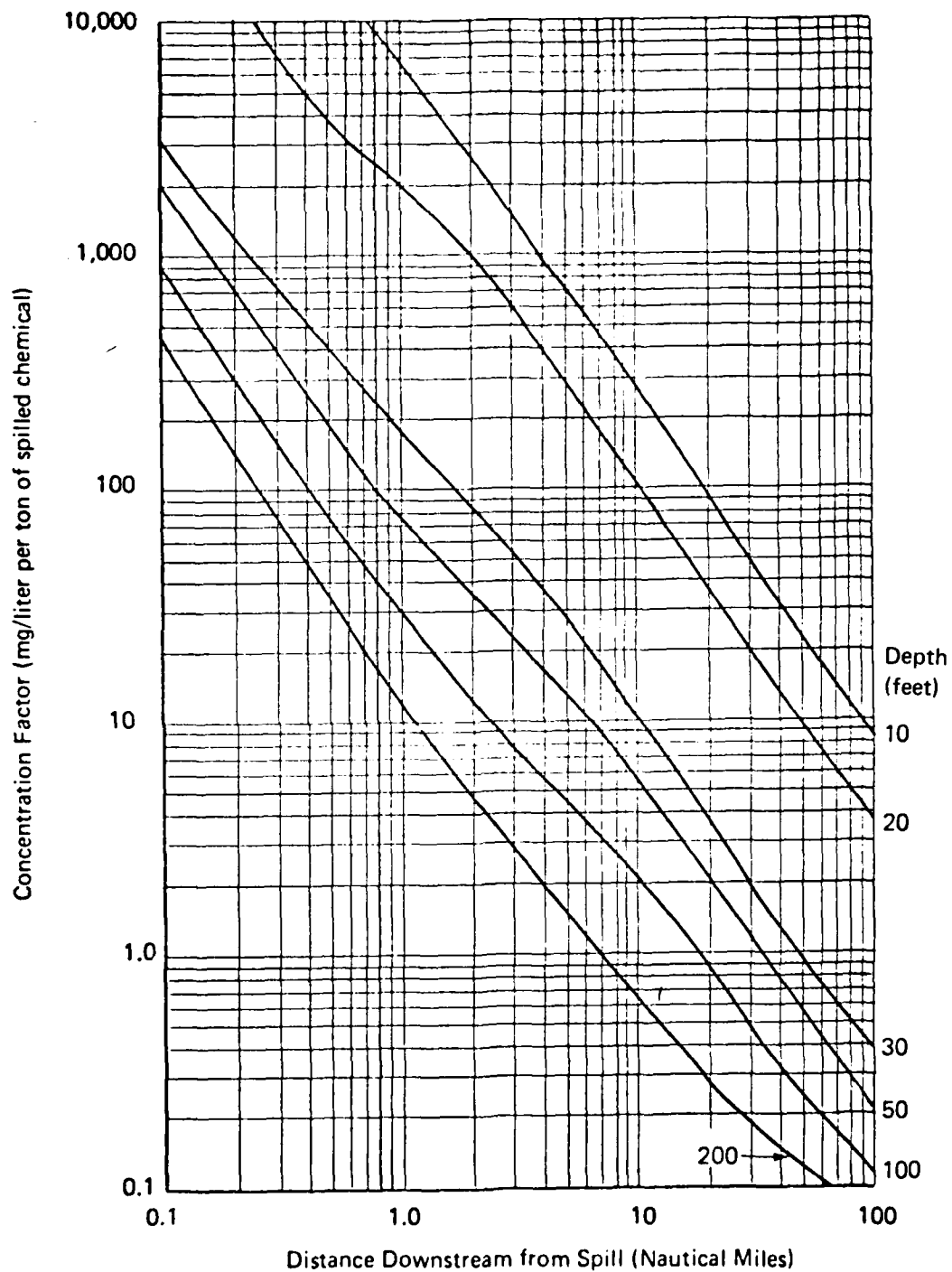


Figure A-8 Concentration Factor for Soluble Chemical in a Flowing Stream
(Width 2200 to 2800 Feet)

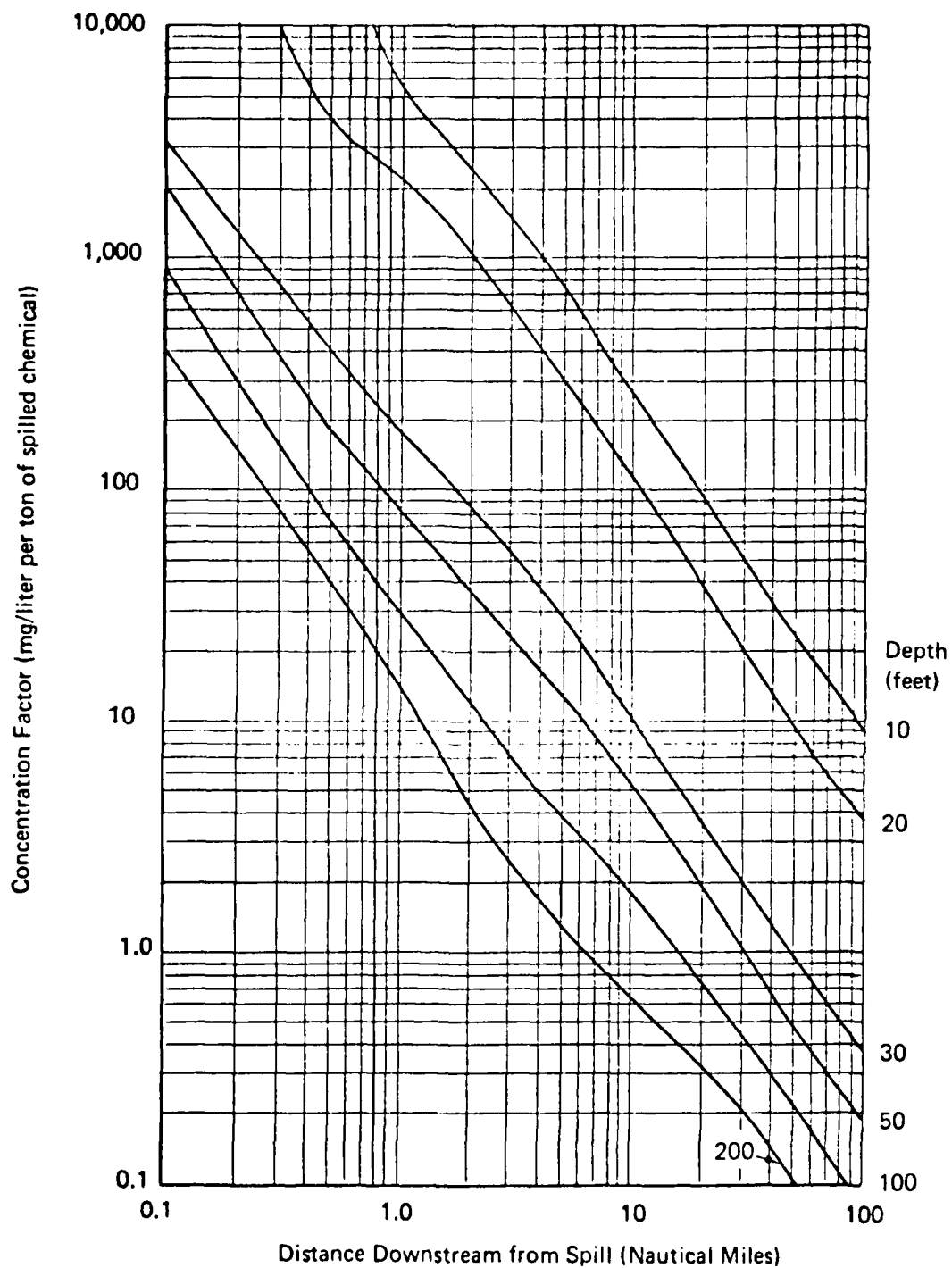


Figure A-9 Concentration Factor for Soluble Chemical in a Flowing Stream
(Width 2800 to 3400 Feet)

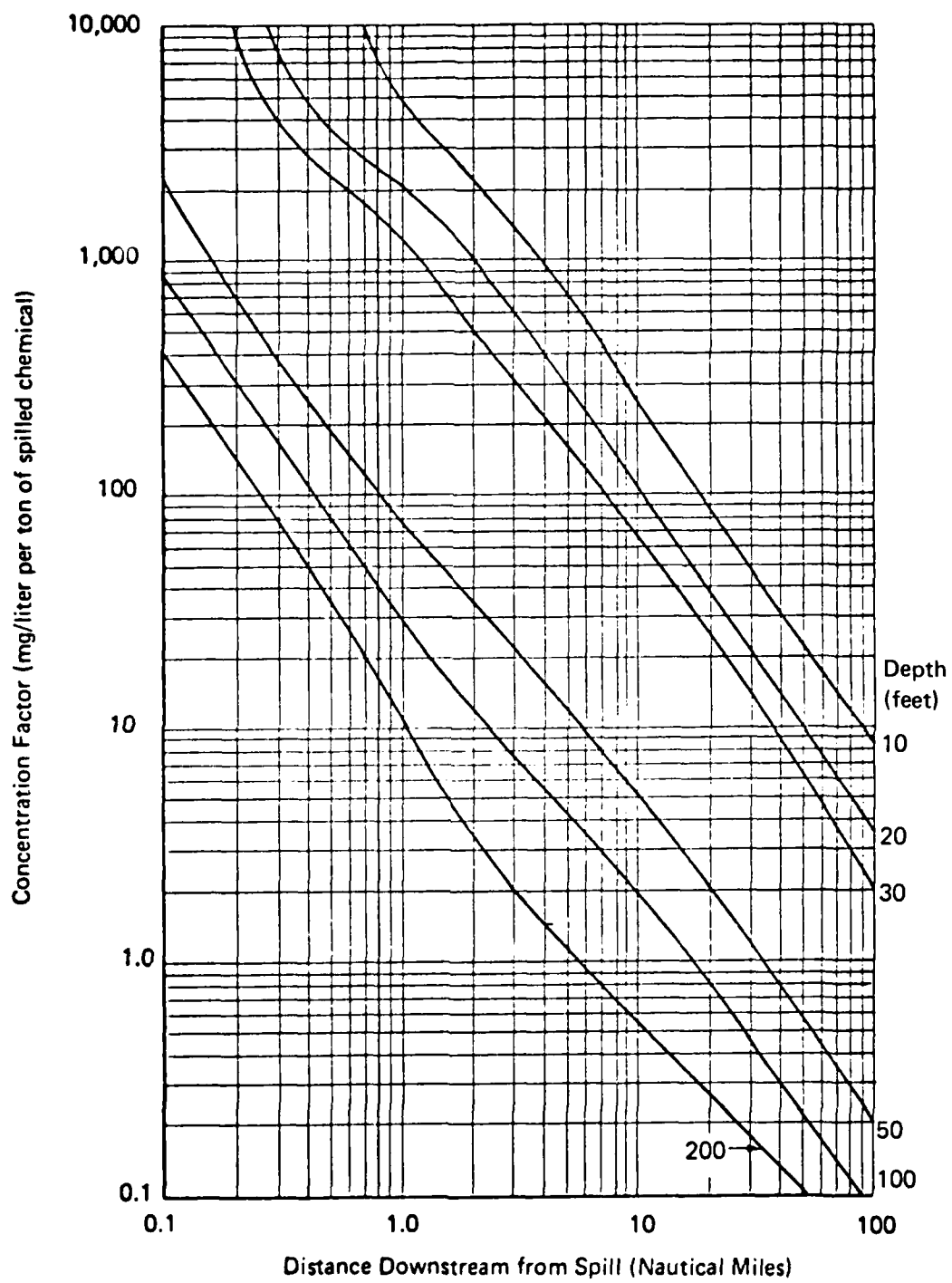


Figure A-10 Concentration Factor for Soluble Chemical in a Flowing Stream (Width Greater than 3400 Feet)

APPENDIX B

DATA TABLES

The following 10 tables contain values of the concentration factor tabulated for a range of values of stream width, stream depth, and distance downstream from the spill location. Concentration factors are given in units of mg/liter per ton of spilled chemical. Data contained in these tables were selected to prepare the graphs for the manual calculation procedure given in Appendix A. In some cases the tables also contain additional data points which could be useful for unusual channel geometries or as interpolation aids. Each table corresponds to a range of values for the stream width. Select the appropriate table for the width of the stream into which the spill has occurred. For stream widths close to the limit of a range, select the table for the smaller category for conservative results. The tables and corresponding width intervals are:

<u>Stream Width (feet)</u>	<u>Table to be Used</u>
0-75	B-1
75-200	B-2
200-400	B-3
400-800	B-4
800-1200	B-5
1200-1800	B-6
1800-2200	B-7
2200-2800	B-8

Stream
Width (feet)

Table to
be Used

2800-3400

B-9

Greater than 3400

B-10

TABLE B-1. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH LESS THAN 75 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet							
	5	10	20	30	50	100	200	
0.1	57134.52	21624.49	12189.79	9561.02	7608.79	6247.53	5602.38	
0.2	27509.54	9661.43	4910.59	4021.44	3356.94	2862.57	2613.18	
0.3	17730.68	6998.40	3258.95	2620.75	2199.67	1874.31	1706.05	
0.4	13186.28	5800.42	2575.82	1954.17	1619.68	1369.62	1240.31	
0.5	10638.40	5032.73	2196.32	1561.60	1264.03	1060.88	956.49	
0.6	8995.99	4453.31	1942.63	1306.80	1024.10	853.91	767.17	
0.7	7826.53	3984.22	1751.88	1130.34	852.71	706.75	633.18	
0.8	6935.47	3592.17	1597.94	1001.53	725.40	597.59	534.17	
0.9	6224.80	3258.86	1468.42	903.16	628.08	513.92	458.53	
1.0	5640.05	2972.39	1356.70	825.12	552.00	448.12	399.21	
2.0	2747.48	1455.35	726.39	453.35	248.84	174.82	154.57	
3.0	1697.61	892.07	464.22	304.09	166.21	99.01	86.82	
4.0	1179.11	616.00	328.04	222.10	125.75	66.64	57.30	
5.0	879.36	457.54	247.23	171.22	100.59	49.79	41.40	
6.0	688.00	356.92	194.79	137.12	83.17	39.82	31.70	
7.0	557.15	288.40	158.55	112.98	70.36	33.34	25.27	
8.0	463.07	239.29	132.28	95.15	60.57	28.79	20.77	
9.0	392.76	202.68	112.53	81.56	52.87	25.41	17.46	
10.0	338.60	174.53	97.24	70.91	46.68	22.78	14.97	
20.0	125.09	64.14	36.31	27.26	19.38	11.08	5.74	
30.0	69.11	35.37	20.13	15.27	11.17	6.99	3.58	
40.0	45.22	23.12	13.20	10.06	7.47	4.93	2.64	
50.0	32.50	16.61	9.50	7.26	5.44	3.72	2.10	
60.0	24.80	12.67	7.25	5.56	4.19	2.93	1.73	
70.0	19.72	10.07	5.77	4.43	3.35	2.39	1.47	
80.0	16.17	8.25	4.73	3.63	2.76	1.99	1.27	
90.0	13.57	6.93	3.97	3.05	2.33	1.70	1.11	
100.0	11.60	5.92	3.40	2.61	1.99	1.47	0.98	

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-2. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 75 TO 200 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet					
	5	10	20	30	50	100
0.1	52987.27	18164.54	8813.32	6272.53	4378.12	3056.93
0.2	25224.65	8060.73	3174.18	2223.60	1562.50	1112.36
0.3	15644.73	5284.67	1857.52	1242.15	890.09	659.05
0.4	10912.18	3896.17	1349.94	861.38	622.72	474.99
0.5	8166.55	3058.59	1097.95	678.92	484.28	374.73
0.6	6411.21	2508.66	950.13	577.78	399.70	310.08
0.7	5213.86	2127.49	852.00	514.64	342.42	264.06
0.8	4358.55	1851.72	780.32	471.02	300.99	229.29
0.9	3725.85	1644.60	724.02	438.24	269.68	201.96
1.0	3244.58	1483.80	677.42	411.91	245.23	179.88
2.0	1433.13	785.46	410.89	263.01	140.12	79.49
3.0	948.35	530.34	281.71	185.69	101.52	48.66
4.0	708.09	390.81	207.37	139.03	78.74	35.16
5.0	559.45	303.48	160.44	108.75	63.43	27.85
6.0	457.73	244.41	128.75	87.93	52.48	23.24
7.0	383.90	202.27	106.20	72.94	44.33	20.02
8.0	328.13	170.96	89.52	61.74	38.08	17.59
9.0	284.73	146.96	76.77	53.13	33.16	15.68
10.0	250.13	128.08	66.78	46.34	29.20	14.13
20.0	101.27	49.80	25.70	18.06	11.94	6.69
30.0	57.83	28.01	14.40	10.16	6.84	4.09
40.0	38.49	18.49	9.49	6.71	4.56	2.82
50.0	27.95	13.37	6.85	4.85	3.31	2.10
60.0	21.47	10.24	5.24	3.71	2.54	1.64
70.0	17.16	8.16	4.18	2.96	2.03	1.32
80.0	14.12	6.70	3.43	2.43	1.67	1.10
90.0	11.88	5.63	2.88	2.04	1.41	0.93
100.0	10.18	4.82	2.46	1.75	1.21	0.80

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-3. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 200 TO 400 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet						
	5	10	20	30	50	100	200
0.1	5089.12	16523.48	7271.28	4838.61	3055.59	1840.69	1284.72
0.2	24137.06	7469.54	2652.83	1713.62	1080.31	650.79	454.29
0.3	14917.93	4895.61	1577.93	947.91	588.14	354.48	248.15
0.4	10382.02	3588.55	1139.89	640.12	382.67	231.22	163.43
0.5	7756.44	2787.64	900.11	484.07	275.64	167.33	120.15
0.6	6077.12	2249.10	744.94	391.99	212.81	129.81	94.90
0.7	4926.93	1865.06	634.42	331.54	173.06	105.81	78.68
0.8	4098.69	1579.44	551.06	288.75	146.54	89.43	67.46
0.9	3478.97	1360.08	485.84	256.83	128.08	77.63	59.23
1.0	3001.06	1187.28	433.54	232.11	114.75	68.78	52.89
2.0	1112.48	472.04	207.66	129.25	68.92	34.03	25.53
3.0	619.22	281.84	141.57	95.01	54.12	23.98	16.15
4.0	414.04	202.74	109.15	75.28	44.31	19.14	11.44
5.0	308.67	160.17	88.79	61.79	37.04	16.12	8.71
6.0	246.75	133.12	74.45	51.92	31.46	13.96	6.98
7.0	206.53	114.03	63.72	44.40	27.10	12.28	5.81
8.0	178.31	99.64	55.38	38.52	23.64	10.94	4.99
9.0	157.31	88.30	48.73	33.82	20.83	9.82	4.38
10.0	140.94	79.10	43.32	30.00	18.53	8.89	3.92
20.0	68.04	36.03	18.61	12.69	7.94	4.20	1.98
30.0	42.71	21.64	10.87	7.36	4.62	2.54	1.31
40.0	30.01	14.80	7.32	4.93	3.10	1.74	0.95
50.0	22.57	10.93	5.35	3.60	2.26	1.29	0.74
60.0	17.76	8.49	4.13	2.77	1.75	1.00	0.59
70.0	14.45	6.85	3.31	2.22	1.40	0.81	0.49
80.0	12.05	5.67	2.73	1.83	1.15	0.67	0.41
90.0	10.25	4.80	2.30	1.54	0.97	0.57	0.35
100.0	8.86	4.12	1.98	1.32	0.83	0.49	0.31

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-4. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 400 TO 800 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet						
	5	10	20	30	50	100	200
0.1	49850.16	15723.46	6524.59	4151.13	2432.86	1284.72	773.91
0.2	23589.12	7173.39	2404.42	1472.60	860.15	454.22	273.62
0.3	14553.01	4698.84	1449.38	821.55	468.44	247.24	148.94
0.4	10116.68	3437.21	1054.59	561.55	305.33	160.59	96.74
0.5	7552.58	2664.93	834.74	429.08	220.63	114.91	69.22
0.6	5914.29	2146.70	690.76	349.73	170.81	87.42	52.67
0.7	4793.05	1777.86	587.44	296.50	138.93	69.38	41.83
0.8	3986.12	1504.01	509.09	257.85	117.16	56.82	34.28
0.9	3382.62	1293.98	447.45	228.18	101.52	47.67	28.81
1.0	2917.38	1128.70	397.68	204.51	89.78	40.79	24.70
2.0	1080.07	441.09	172.24	95.49	43.18	16.19	9.82
3.0	597.17	248.60	101.24	58.75	28.92	11.16	6.30
4.0	390.93	164.37	68.83	41.55	22.16	9.22	4.74
5.0	281.05	118.97	51.22	32.13	18.27	8.09	3.86
6.0	214.49	91.38	40.59	26.35	15.69	7.27	3.30
7.0	170.61	73.25	33.64	22.47	13.80	6.60	2.91
8.0	139.93	60.68	28.81	19.67	12.33	6.03	2.62
9.0	117.51	51.60	25.28	17.54	11.14	5.53	2.39
10.0	100.57	44.81	22.58	15.85	10.14	5.09	2.20
20.0	38.16	19.87	11.15	7.92	5.05	2.63	1.24
30.0	23.62	13.07	7.22	5.02	3.14	1.65	0.83
40.0	17.38	9.65	5.18	3.54	2.19	1.15	0.60
50.0	13.79	7.54	3.95	2.67	1.63	0.86	0.46
60.0	11.40	6.12	3.14	2.10	1.28	0.68	0.37
70.0	9.66	5.10	2.57	1.71	1.04	0.55	0.30
80.0	8.35	4.33	2.16	1.43	0.86	0.46	0.25
90.0	7.31	3.74	1.84	1.22	0.73	0.39	0.22
100.0	6.48	3.27	1.60	1.05	0.63	0.33	0.19

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-5. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 800 TO 1200 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet						
	5	10	20	30	50	100	200
0.1	288993.09	15328.65	6157.96	3815.55	2132.66	1022.89	540.16
0.2	136598.28	7025.00	2283.37	1355.45	754.03	361.65	190.97
0.3	84195.48	4599.63	1386.27	760.58	410.85	196.86	103.95
0.4	58496.22	3360.91	1012.12	523.62	268.39	127.86	67.52
0.5	43653.79	2603.16	801.85	402.34	194.78	91.49	48.31
0.6	34175.47	2095.22	663.35	329.08	151.66	69.61	36.75
0.7	27691.00	1734.09	563.70	279.50	124.09	55.27	29.17
0.8	23025.64	1466.20	488.07	243.23	105.23	45.29	23.87
0.9	19537.24	1260.90	428.57	215.25	91.60	38.04	20.01
1.0	16848.48	1099.44	380.56	192.84	81.31	32.59	17.08
2.0	6234.80	428.88	163.88	89.32	39.14	12.84	6.05
3.0	3446.66	241.56	95.97	54.28	25.14	8.17	3.36
4.0	2256.15	159.64	64.75	37.39	17.98	6.07	2.31
5.0	1621.95	115.43	47.42	27.75	13.69	4.84	1.81
6.0	1237.72	88.43	36.64	21.64	10.89	4.04	1.53
7.0	984.40	70.53	29.40	17.49	8.95	3.48	1.36
8.0	807.08	57.94	24.27	14.52	7.54	3.08	1.24
9.0	677.26	48.70	20.48	12.31	6.49	2.76	1.15
10.0	578.86	41.68	17.58	10.62	5.69	2.52	1.08
20.0	205.62	14.91	6.54	4.23	2.60	1.40	0.70
30.0	112.10	8.25	3.89	2.68	1.74	0.96	0.50
40.0	72.87	5.54	2.81	1.99	1.30	0.72	0.37
50.0	52.17	4.17	2.22	1.58	1.03	0.56	0.29
60.0	39.70	3.36	1.84	1.31	0.84	0.45	0.24
70.0	31.51	2.83	1.57	1.11	0.71	0.37	0.20
80.0	25.79	2.45	1.36	0.96	0.60	0.32	0.17
90.0	21.62	2.17	1.20	0.84	0.52	0.27	0.14
100.0	18.46	1.94	1.07	0.74	0.46	0.24	0.11

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-6. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 1200 TO 1800 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet					
	5	10	20	30	50	100 200
0.1	287964.75	89044.62	6036.79	3704.97	2034.38	938.38 466.21
0.2	136060.22	40869.63	2243.50	1316.94	719.29	331.77 164.83
0.3	83838.08	26754.95	1365.39	740.61	392.02	180.59 89.72
0.4	58236.85	19542.16	997.97	511.18	256.35	117.30 58.28
0.5	43454.77	15131.04	790.84	393.53	186.39	83.94 41.70
0.6	34016.65	12175.25	654.15	322.23	145.15	63.87 31.72
0.7	27560.52	10074.48	555.73	273.83	119.27	50.72 25.17
0.8	22915.98	8516.62	481.00	238.33	101.34	41.59 20.60
0.9	19443.43	7323.04	422.23	210.90	88.36	34.96 17.27
1.0	16767.04	6384.52	374.81	188.91	78.53	29.98 14.74
2.0	6203.73	2489.05	161.09	87.27	37.85	12.00 5.23
3.0	3429.31	1401.61	94.26	52.94	24.26	7.69 2.91
4.0	2244.73	926.17	63.56	36.43	17.31	5.70 1.98
5.0	1613.71	669.64	46.53	27.02	13.16	4.51 1.51
6.0	1231.42	512.97	35.95	21.06	10.44	3.70 1.23
7.0	979.39	409.11	28.85	17.01	8.54	3.12 1.05
8.0	802.96	336.11	23.81	14.11	7.16	2.68 0.93
9.0	673.80	282.50	20.09	11.95	6.11	2.33 0.83
10.0	575.90	241.77	17.24	10.29	5.30	2.06 0.76
20.0	204.57	86.39	6.24	3.79	2.05	0.95 0.45
30.0	111.53	47.19	3.44	2.13	1.22	0.64 0.33
40.0	72.50	30.71	2.27	1.45	0.88	0.49 0.26
50.0	51.90	21.99	1.67	1.10	0.70	0.39 0.21
60.0	39.49	16.74	1.32	0.90	0.58	0.32 0.18
70.0	31.35	13.29	1.10	0.76	0.49	0.28 0.15
80.0	25.66	10.88	0.94	0.66	0.43	0.24 0.13
90.0	21.51	9.12	0.83	0.58	0.38	0.21 0.11
100.0	18.37	7.79	0.74	0.52	0.34	0.18 0.10

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-7. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 1800 TO 2200 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet					
	5	10	20	30	50	100 200
0.1	287278.87	88534.85	5956.32	3631.61	1969.39	882.86 418.16
0.2	135701.25	40676.08	2217.05	1291.43	696.31	312.14 147.84
0.3	83599.73	26625.09	1351.51	727.40	379.58	169.91 80.48
0.4	58063.89	19442.29	988.54	502.94	248.41	110.36 52.27
0.5	43322.09	15050.27	783.48	387.67	180.86	78.97 37.40
0.6	33910.79	12108.01	648.00	317.67	141.36	60.10 28.45
0.7	27473.54	10017.36	550.40	270.04	116.10	47.74 22.58
0.8	22842.90	8467.32	476.28	235.06	98.78	39.16 18.48
0.9	19380.90	7279.92	417.99	208.00	86.22	32.94 15.49
1.0	16712.76	6346.41	370.97	186.29	76.68	28.27 13.22
2.0	6183.02	2473.19	159.23	85.89	36.99	11.45 4.70
3.0	3417.74	1392.47	93.12	52.05	23.66	7.37 2.63
4.0	2237.12	920.06	62.77	35.80	16.86	5.46 1.81
5.0	1608.22	665.20	45.95	26.54	12.81	4.31 1.39
6.0	1227.23	509.55	35.49	20.68	10.15	3.54 1.13
7.0	976.05	406.37	28.48	16.70	8.30	2.97 0.96
8.0	800.22	333.86	23.50	13.85	6.96	2.55 0.84
9.0	671.50	280.61	19.82	11.72	5.94	2.21 0.74
10.0	573.93	240.14	17.02	10.09	5.14	1.95 0.66
20.0	203.87	85.80	6.16	3.71	1.95	0.80 0.32
30.0	111.15	46.87	3.38	2.04	1.09	0.47 0.22
40.0	72.25	30.50	2.20	1.34	0.72	0.34 0.17
50.0	51.72	21.84	1.58	0.96	0.53	0.26 0.14
60.0	39.36	16.63	1.21	0.74	0.42	0.22 0.12
70.0	31.24	13.20	0.96	0.60	0.35	0.19 0.10
80.0	25.57	10.81	0.79	0.50	0.30	0.16 0.09
90.0	21.43	9.06	0.67	0.43	0.26	0.14 0.08
100.0	18.30	7.74	0.58	0.37	0.23	0.13 0.07

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-8. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 2200 TO 2800 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet					
	5	10	20	30	50	100
0.1	287029.34	88349.72	34727.20	3605.01	1945.86	862.84
0.2	135570.69	40605.68	12933.60	1282.18	688.00	305.06
0.3	83513.04	26577.82	7889.06	722.61	375.08	166.05
0.4	58001.02	19405.95	5771.83	499.95	245.54	107.86
0.5	43273.85	15020.87	4574.76	385.55	178.86	77.18
0.6	33872.31	12083.55	3783.56	316.01	139.88	58.74
0.7	27441.93	9996.59	3213.42	268.66	114.95	46.66
0.8	22816.33	8449.38	2780.48	233.87	97.85	38.28
0.9	19358.18	7264.25	2439.98	206.94	85.44	32.21
1.0	16693.03	6332.56	2165.33	185.33	76.01	27.66
2.0	6175.50	2467.43	928.96	85.39	36.68	11.25
3.0	3413.54	1389.15	543.16	51.73	23.45	7.25
4.0	2234.36	917.85	366.11	35.56	16.70	5.38
5.0	1606.23	663.58	267.96	26.36	12.68	4.24
6.0	1225.70	508.31	206.98	20.54	10.05	3.48
7.0	974.83	405.38	166.06	16.58	8.22	2.92
8.0	799.22	333.04	137.05	13.75	6.88	2.50
9.0	670.66	279.92	115.60	11.64	5.87	2.17
10.0	573.21	239.55	99.21	10.02	5.09	1.91
20.0	203.61	85.59	35.91	3.68	1.92	0.78
30.0	111.01	46.75	19.70	2.03	1.07	0.45
40.0	72.16	30.42	12.85	1.33	0.71	0.31
50.0	51.66	21.79	9.22	0.95	0.51	0.23
60.0	39.31	16.59	7.02	0.73	0.39	0.18
70.0	31.20	13.17	5.58	0.58	0.32	0.16
80.0	25.54	10.78	4.57	0.48	0.27	0.13
90.0	21.41	9.04	3.83	0.40	0.23	0.12
100.0	18.28	7.72	3.27	0.35	0.20	0.11
						0.06

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-9. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH 2800 TO 3400 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet						
	5	10	20	30	50	100	200
0.1	286788.84	88171.30	34562.41	3579.39	1923.23	843.62	384.50
0.2	135446.77	40537.77	12879.51	1273.28	680.00	298.26	135.94
0.3	83429.44	26532.21	7860.63	718.01	370.75	162.35	74.00
0.4	57940.38	19370.88	5752.46	497.08	242.78	105.45	48.06
0.5	43227.34	14992.52	4559.63	383.51	176.94	75.46	34.39
0.6	33835.20	12059.95	3770.90	314.42	138.46	57.43	26.16
0.7	27411.45	9976.54	3202.44	267.34	113.85	45.63	20.76
0.8	22790.72	8432.09	2770.75	232.72	96.96	37.45	16.99
0.9	19336.26	7249.13	2431.25	205.91	84.69	31.51	14.24
1.0	16674.01	6319.19	2157.42	184.40	75.37	27.07	12.16
2.0	6168.24	2461.87	925.14	84.91	36.38	11.06	4.32
3.0	3409.49	1385.95	540.81	51.41	23.24	7.14	2.44
4.0	2231.69	915.71	364.49	35.34	16.54	5.29	1.69
5.0	1604.31	662.02	266.76	26.19	12.55	4.18	1.30
6.0	1224.23	507.11	206.04	20.40	9.95	3.42	1.07
7.0	973.66	404.42	165.30	16.47	8.13	2.87	0.91
8.0	798.26	332.25	136.42	13.66	6.81	2.46	0.79
9.0	669.85	279.25	115.07	11.57	5.81	2.13	0.70
10.0	572.52	238.98	98.76	9.96	5.03	1.88	0.63
20.0	203.37	85.38	35.74	3.65	1.90	0.77	0.29
30.0	110.87	46.64	19.61	2.01	1.06	0.44	0.18
40.0	72.07	30.35	12.79	1.32	0.70	0.29	0.12
50.0	51.59	21.74	9.17	0.95	0.50	0.21	0.10
60.0	39.26	16.55	6.99	0.72	0.38	0.17	0.08
70.0	31.16	13.14	5.55	0.57	0.31	0.14	0.07
80.0	25.51	10.76	4.55	0.47	0.25	0.11	0.06
90.0	21.38	9.02	3.81	0.39	0.21	0.10	0.05
100.0	18.26	7.70	3.26	0.34	0.18	0.09	0.05

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

TABLE B-10. CONCENTRATION FACTOR FOR SOLUBLE CHEMICAL IN A FLOWING STREAM
(WIDTH GREATER THAN 3400 FEET)

Distance Downstream from Spill in Nautical Miles	River Depth in Feet						
	5	10	20	30	50	100	200
0.1	286612.31	88040.59	34441.64	20861.90	1906.66	829.58	372.52
0.2	135352.39	40487.98	12839.88	7422.02	674.14	293.30	131.71
0.3	83368.13	26498.76	7839.79	4187.10	367.58	159.65	71.69
0.4	57895.90	19345.16	5738.25	2900.09	240.77	103.70	46.57
0.5	43193.22	14971.72	4548.53	2238.20	175.54	74.21	33.32
0.6	33807.98	12042.64	3761.61	1835.31	137.42	56.48	25.35
0.7	27389.09	9961.85	3194.38	1560.63	113.04	44.88	20.11
0.8	22771.94	8419.41	2763.61	1358.57	96.30	36.83	16.46
0.9	19320.19	7238.04	2424.84	1202.07	84.15	31.01	13.80
1.0	16660.06	6309.39	2151.62	1076.43	74.90	26.65	11.78
2.0	6162.92	2457.80	922.34	495.40	36.15	10.92	4.19
3.0	3406.52	1383.61	539.10	299.88	23.09	7.05	2.37
4.0	2229.74	914.14	363.30	206.10	16.43	5.23	1.64
5.0	1602.90	660.88	265.88	152.72	12.46	4.13	1.27
6.0	1223.15	506.23	205.35	118.97	9.87	3.38	1.04
7.0	972.80	403.72	164.75	96.05	8.07	2.83	0.89
8.0	797.55	331.67	135.96	79.64	6.76	2.42	0.77
9.0	669.26	278.76	114.68	67.43	5.77	2.11	0.68
10.0	572.02	238.57	98.42	58.04	4.99	1.85	0.61
20.0	203.19	85.23	35.62	21.30	1.89	0.75	0.28
30.0	110.77	46.56	19.54	11.74	1.05	0.43	0.17
40.0	72.01	30.29	12.74	7.67	0.69	0.29	0.12
50.0	51.55	21.70	9.14	5.51	0.50	0.21	0.09
60.0	39.23	16.52	6.96	4.20	0.38	0.16	0.07
70.0	31.13	13.12	5.53	3.34	0.30	0.13	0.06
80.0	25.49	10.74	4.53	2.74	0.25	0.11	0.05
90.0	21.36	9.00	3.80	2.30	0.21	0.09	0.04
100.0	18.24	7.69	3.25	1.96	0.18	0.08	0.04

Note: Concentration factors are given in units of mg/liter per ton of spilled chemical.

APPENDIX C

HAZARDOUS CHEMICAL DATA

Manual Two of the Chemical Hazard Response Information System (CHRIS), published in October 1978 by the U.S. Coast Guard, is a compendium of chemical and physical property data for 900 commonly shipped hazardous chemicals. For each of these substances, the manual lists the specific chemical, physical, and biological data needed for the preparation and use of the other components of the CHRIS system. The manual can also be used after the initial response action, when there is sufficient time to use more detailed information, and can serve as a reference for investigating classes of hazardous materials and action on discharge.

Much of the quantitative data contained in Manual Two is needed for the hazard assessment calculations described in the Hazard Assessment Handbook and Hazard Assessment Computer System (HACS) modules of CHRIS. For use with HACS, the appropriate chemical property data has been transcribed to a separate computer file which is automatically accessed during computations to obtain this data.


The Hazardous Chemical Data manual contains, for each chemical, the Hazard Assessment Code which directs the user of the Hazard Assessment Handbook or HACS to the appropriate calculation procedure. The Hazardous Chemical Data manual also suggests general responses to an accidental discharge which summarize the detailed information given in the Response Methods Handbook.

This Appendix contains excerpts from the Hazardous Chemical Data Manual of CHRIS, specifically, individual data sheets for 27 selected

substances. The data sheets are arranged in alphabetical order by compound name. The complete U.S. Coast Guard publication should be referenced for explanation of terms, use of conversion factors, compatibility guides, and additional indices.

BNZ

BENZENE

Common Synonyms Benzol Benzole		Watery liquid	Colorless	Gasoline-like odor
Floats on water. Flammable, irritating vapor is produced. Freezing point is 42° F.				
Avoid contact with liquid and vapor. Keep people away. Wear goggles and self-contained breathing apparatus. Shut off ignition sources and call fire department. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.				
Fire		FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.		
Exposure		CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.		
Water Pollution		HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operation of nearby water intakes.		
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning - high flammability Restrict access		2. LABEL 		
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Benzol Benzole 3.2 Coast Guard Competibility Classification: Aromatic hydrocarbon 3.3 Chemical Formula: C ₆ H ₆ 3.4 IMCO/United Nations Numerical Designation: 12.1114		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Aromatic, rather pleasant aromatic odor, characteristic odor		
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Hydrocarbon vapor canister, supplied air or a hose mask, hydrocarbon insoluble rubber or plastic gloves, chemical goggles or face splash shield, hydrocarbon insoluble apron such as neoprene 5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction, coma and possible death 5.3 Treatment for Exposure: SKIN: Flush with water followed by soap and water, remove contaminated clothing and wash skin. EYES: Flush with plenty of water until irritation subsides. INHALATION: Remove from exposure immediately. Call a physician. If breathing is irregular or stopped, start resuscitation, administer oxygen 5.4 Toxicity by Inhalation (Threshold Limit Value): 25 ppm 5.5 Short-Term Inhalation: Limits: 75 ppm for 30 min 5.6 Toxicity by Ingestion: Grade 3, 1 Dn 50 to 500 mg/kg 5.7 Late Toxicity: Leukemia 5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin 5.10 Odor Threshold: 4 NR ppm				

6. FIRE HAZARDS

6.1 **Flash Point:** 12° F (4° C)
 6.2 **Flammable Limit - in Air:**
1.3% - 7.9%
 6.3 **Fire Extinguishing Agents:** Dry chemical, foam, or carbon dioxide
 6.4 **Fire Extinguishing Agents Not to be Used:**
Water may be ineffective
 6.5 **Special Hazards of Combustion Products:**
Not pertinent
 6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back
 6.7 **Ignition Temperature:** 1097° F
 6.8 **Electrical Hazard:** Class I, Group D
 6.9 **Burning Rate:** 6.0 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction
 7.2 **Reactivity with Common Materials:**
No reaction
 7.3 **Stability During Transport:** Stable
 7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
 7.5 **Polymerization:** Not pertinent
 7.6 **Inhibitor of Polymerization:**
Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
5 ppm 6 hr minnow (debat distilled water)
20 ppm 24 hr sunfish (11 in tap water)
 8.2 **Waterproof Toxicity:** Data not available
 8.3 **Biological Oxygen Demand (BOD):**
1.2 lb/lb 10 days
 8.4 **Food Chain Concentration Potential:**
None

9. SELECTED MANUFACTURERS

1. Commonwealth Oil Refining Co., Inc.
Commonwealth Petrochemicals Co.
Pensacola, Puerto Rico 00724
 2. Phillips Petroleum Co.
Phillips Puerto Rico Core, Inc.
Banco Popular Center
Hato Rey, P. R. 00936
 3. Shell Chemical Co.
Petrochemicals Div.
P. O. Box 2463
Houston, Texas 77001

10. SHIPPING INFORMATION

10.1 **Grades or Purities:**
 Industrial pure 99.4%
 Thiophene-free 99.4%
 Nitration 99.4%
 Industrial 90% 85.4%
 Reagent 99.4%
 10.2 **Storage Temperature:** Ambient
 10.3 **Inert Atmosphere:** No requirement
 10.4 **Venting:** Pressure/vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-T-L-V-W

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:**
Flammable liquid
 12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	1
Water Pollution	1
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self-Reaction	0

12.3 **MFPA Hazard Classifications:**


Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15° C and 1 atm:** Liquid
 13.2 **Molecular Weight:** 78.11
 13.3 **Boiling Point at 1 atm:**
178° F = 80.1° C = 353.3° K
 13.4 **Freezing Point:**
42.0° F = 5.5° C = 278.7° K
 13.5 **Critical Temperature:**
552.0° F = 288.9° C = 562.1° K
 13.6 **Critical Pressure:**
210 psia = 48.3 atm = 4.89 MN/m²
 13.7 **Specific Gravity:** 0.879 at 20° C (liquids)
 13.8 **Liquid Surface Tension:**
28.9 dynes/cm = 0.0289 N/m at 20° C
 13.9 **Liquid-Water Interfacial Tension:**
35.0 dynes/cm = 0.035 N/m at 20° C
 13.10 **Vapor (Gas) Specific Gravity:** 2.7
 13.11 **Ratio of Specific Heats of Vapor (Gas):**
1.061
 13.12 **Latent Heat of Vaporization:**
169 Btu/lb = 94.1 cal/g = 3.94 x 10³ J/kg
 13.13 **Heat of Combustion:** -17,461 Btu/lb
= -9698 cal/g = -416.0 x 10³ J/kg
 13.14 **Heat of Decomposition:** Not pertinent
 13.15 **Heat of Solution:** Not pertinent
 13.16 **Heat of Polymerization:** Not pertinent

(Continued on pages 5 and 6.)

NOTES

Common Synonyms Cresylic acids Hydroxytoluenes Methylphenols Oxytoluenes	Watery liquid, or solid crystals Colorless or yellow Sweet tarry odor Sinks in water.
Avoid contact with liquid. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Combustible POISONOUS GASES MAY BE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Extinguish with water, dry chemical, foam or carbon dioxide. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. LIQUID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook CG 446-4)</small> Issue warning - water contaminant, poison. Restrict access. Should be removed. Chemical and physical treatment.	2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Cresylic acids Hydroxytoluenes Methylphenols Oxytoluenes Tar acids 3.2 Coast Guard Compatibility Classification: Cresol 3.3 Chemical Formula: $\text{C}_6\text{H}_4(\text{OH})_2$ 3.4 IMCO/United Nations Numerical Designation: 9.0.2022	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid or solid 4.2 Color: Colorless to dark yellow 4.3 Odor: Sweet, tarry
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Organic vapor canister unit (USBM Type B) approved by U.S. Bureau of Mines. Rubber gloves, chemical safety goggles, face shield, coveralls and/or rubber apron, rubber shoes or boots. 5.2 Symptoms Following Exposure: Vapors cause irritation of eyes, nose, and throat. Contact with skin or eyes causes severe burns. Chemical is rapidly absorbed through skin. 5.3 Treatment for Exposure: Call a physician. INHALATION: remove to fresh air. INGESTION: have victim drink water or milk, do NOT induce vomiting. SKIN OR EYES: flush immediately with plenty of water for at least 15 min.; remove contaminated clothing immediately and wash before reuse; discard contaminated shoes. 5.4 Toxicity by Inhalation (Threshold Limit Value): 5 ppm 5.5 Short-Term Inhalation Limits: Data not available 5.6 Toxicity by Ingestion: Grade 2.1 D ₅₀ 5 to 5 g/kg (rat, rabbit) 5.7 Lethal Toxicity: Data not available 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant; may cause pain and second-degree burns after a few minutes' contact. 5.10 Odor Threshold: 5 ppm	

6. FIRE HAZARDS

- 6.1 **Flash Point:** 175-185°F O.C., 178°F C.C.
 6.2 **Flammable Limits in Air:** 1.1% - 1.4% (ortho), 1.1% (meta or para)
 6.3 **Fire Extinguishing Agents:** Water, dry chemical, carbon dioxide, and foam
 6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
 6.5 **Special Hazards of Combustion Products:** Flammable toxic vapors given off in a fire
 6.6 **Behavior in Fire:** Sealed closed containers can build up pressure if exposed to heat (fire)
 6.7 **Ignition Temperature:** 1110°F (o-cresol), 1038°F (m or p-cresol)
 6.8 **Electrical Hazard:** Data not available
 6.9 **Burning Rate:** Data not available

7. CHEMICAL REACTIVITY

- 7.1 **Reactivity with Water:** No reaction
 7.2 **Reactivity with Common Materials:** No reaction
 7.3 **Stability During Transport:** Stable
 7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
 7.5 **Polymerization:** Not pertinent
 7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

- 8.1 **Aquatic Toxicity:** 24 mg/l, 96 hr, bluegill; 11 mg/l, fresh water, 10-100 ppm, 48 hr, shrimp; 11 mg/l, salt water
 8.2 **Waterfowl Toxicity:** Data not available
 8.3 **Biological Oxygen Demand (BOD):** m-cresol: 170%, 5 days
 m-cresol: 164%, 5 days
 p-cresol: 144%, 5 days
 8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Allied Chemical Corp.
Plastics Division
Morristown, N. J. 07960
2. Continental Oil Co.
Pitt-Consol Chemicals Division
Park 80 Plaza East
Saddle Brook, N. J. 07662
3. Koppers Co., Inc.
Organic Materials Division
Pittsburgh, Pa. 15219

10. SHIPPING INFORMATION

- 10.1 **Grades or Purity:**
 USP Liquid (mixed isomers)
 Phenol-cresol mixtures
 Ortho-cresol 80 to 98% containing phenol
 Meta-cresol 80 to 98% containing other cresols and xylenols
 Para-cresol 92 to 98% containing meta-cresol
 Meta-para-cresol containing ortho-cresol and xylenols

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook CG 446-3)
 A-P-Q-T-U-X-Y

12. HAZARD CLASSIFICATIONS

- 12.1 **Code of Federal Regulations:**
 Poisonous liquid or solid, Class B
 12.2 **NAS Hazard Rating for Bulk Water Transportation:**
- | Category | Rating |
|--------------------------|--------|
| Fire | 1 |
| Health | 2 |
| Vapor Irritant | 3 |
| Liquid or Solid Irritant | 2 |
| Poisons | 2 |
| Water Pollution | 1 |
| Human Toxicity | 3 |
| Aquatic Toxicity | 4 |
| Aesthetic Effect | 4 |
| Reactivity | 0 |
| Other Chemicals | 2 |
| Water | 0 |
| Self-Reaction | 0 |

12.3 NFPA Hazard Classifications:

Category	Classification	
	meta and ortho	para
Health Hazard (Blue)	3	3
Flammability (Red)	2	1
Reactivity (Yellow)	0	0

13. PHYSICAL AND CHEMICAL PROPERTIES

- 13.1 **Physical State at 15°C and 1 atm:** Liquid
 13.2 **Molecular Weight:** 108.13
 13.3 **Boiling Point at 1 atm:**
 $> 350^\circ\text{F}$ = $> 177^\circ\text{C}$ = $> 450^\circ\text{K}$
 13.4 **Freezing Point:** Not pertinent
 13.5 **Critical Temperature:** Not pertinent
 13.6 **Critical Pressure:** Not pertinent
 13.7 **Specific Gravity:** 1.03 - 1.07 at 20°C (liquid)
 13.8 **Liquid Surface Tension:**
 37 dynes/cm = 0.037 N/m at 20°C
 13.9 **Liquid-Water Interfacial Tension:**
 Data not available
 13.10 **Vapor (Gas) Specific Gravity:**
 Not pertinent
 13.11 **Ratio of Specific Heats of Vapor (Gas):**
 1.073
 13.12 **Latent Heat of Vaporization:**
 (est) 1200 Btu/lb = 110 cal/g = 4.6×10^4 J/kg
 13.13 **Heat of Combustion:**
 -14,720 to -14,740 Btu/lb
 = -8180 to -8190 cal/g
 = -342.5 to -342.9 $\times 10^3$ J/kg
 13.14 **Heat of Decomposition:** Not pertinent
 13.15 **Heat of Solution:** Not pertinent
 13.16 **Heat of Polymerization:** Not pertinent

(Continued on pages 5 and 6)

16. SHIPPING INFORMATION (Cont'd.)

- "Resin" cresols containing phenols and xylenols
 Cresylic acids containing xylenols, cresols and phenols
 10.2 **Storage Temperature:** Ambient
 10.3 **Inert Atmosphere:** No requirement
 10.4 **Ventilating:** Open

Common Synonyms Methylene chloride Methylene dichloride		Watery liquid	Colorless	Sweet, pleasant odor
		Sinks in water. Irritating vapor is produced.		
Stop discharge if possible. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.				
Fire	Not flammable. POISONOUS GASES ARE PRODUCED WHEN HEATED. Wear goggles and self-contained breathing apparatus. Cool exposed containers with water.			
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea and dizziness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES , hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS , have victim drink water or milk.			
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and pollution control officials. Notify operators of nearby water intakes.			
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446.4) Disperse and flush.		2. LABELS No hazard label required by Code of Federal Regulations.		
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Methylene chloride Methylene dichloride 3.2 Coast Guard Compatibility Classification: Halogenated hydrocarbon 3.3 Chemical Formula: CH ₂ Cl ₂ 3.4 IMCO/United Nations Numerical Designation: 9.0 (593)		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Pleasant, aromatic, like chloroform, sweet, ethereal		
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Organic vapor canister mask, safety glasses, protective clothing 5.2 Symptoms Following Exposure: INHALATION: anesthetic effects, nausea and drunkenness. CONTACT WITH SKIN AND EYES: skin irritation, irritation of eyes and nose 5.3 Treatment for Exposure: INHALATION: remove from exposure. Give oxygen if needed. INGESTION: no specific antidote. CONTACT WITH SKIN AND EYES: remove contaminated clothing, wash skin or eyes if affected 5.4 Toxicity by Inhalation (Threshold Limit Value): 500 ppm 5.5 Short-Term Inhalation Limits: 100 ppm for 60 min. 5.6 Toxicity by Ingestion: Grade 2, LD ₅₀ 0.5 to 5 g/kg 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin 5.10 Odor Threshold: 205-307 ppm				

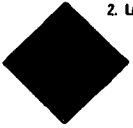

6. FIRE HAZARDS 6.1 Flash Point: Not flammable under conditions likely to be encountered 6.2 Flammable Limits in Air: 12% - 19% 6.3 Fire Extinguishing Agents: Not pertinent 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Dissociation products generated in a fire may be irritating or toxic 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 1184 °F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not pertinent		8. WATER POLLUTION 8.1 Aquatic Toxicity: Not pertinent 8.2 Waterfowl Toxicity: Not pertinent 8.3 Biological Oxygen Demand (BOD): Not pertinent 8.4 Food Chain Concentration Potential: None																													
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent		9. SELECTED MANUFACTURERS 1. Ancon Chemical Corp. Westlake, La. 70669 2. Dow Chemical Co. Midland, Mich. 48640 3. Ethyl Corp. Industrial Chemicals Division 451 Florida St. Baton Rouge, La. 70801																													
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446.3) A-P-X		10. SHIPPING INFORMATION 10.1 Grades or Purity: Acetone grade, technical grade 10.2 Storage Temperature: Data not available 10.3 Inert Atmosphere: Inerted 10.4 Venting: Data not available																													
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: ORM-A 12.2 NAS Hazard Rating for Bulk Water Transportation: <table><tr><th>Category</th><th>Rating</th></tr><tr><td>Fire</td><td>1</td></tr><tr><td>Health</td><td></td></tr><tr><td>Vapor Irritant</td><td>2</td></tr><tr><td>Liquid or Solid Irritant</td><td>1</td></tr><tr><td>Poisons</td><td>2</td></tr><tr><td>Water Pollution</td><td></td></tr><tr><td>Human Toxicity</td><td>1</td></tr><tr><td>Aquatic Toxicity</td><td>2</td></tr><tr><td>Aesthetic Effect</td><td>2</td></tr><tr><td>Reactivity</td><td></td></tr><tr><td>Other Chemicals</td><td>1</td></tr><tr><td>Water</td><td>0</td></tr><tr><td>Self-Reaction</td><td>0</td></tr></table>		Category	Rating	Fire	1	Health		Vapor Irritant	2	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self-Reaction	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 84.93 13.3 Boiling Point at 1 atm: 104.1 °F = 39.5 °C = 313.0 K 13.4 Freezing Point: -142.1 °F = -96.7 °C = 176.5 K 13.5 Critical Temperature: 473.3 °F = 245 °C = 518 K 13.6 Critical Pressure: 895 psia = 60.9 atm = 6.12 MN/m ² 13.7 Specific Gravity: 1.322 at 20 °C (liquids) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: 2.9 13.11 Ratio of Specific Heats of Vapor (Gas): 1.199 13.12 Latent Heat of Vaporization: 142 Btu/lb = 76.7 cal/g = 3.30 x 10 ⁵ J/kg 13.13 Heat of Combustion: Not pertinent 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent	
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12.3 NFPA Hazard Classifications: <table><tr><th>Category</th><th>Classification</th></tr><tr><td>Health Hazard (Blue)</td><td>2</td></tr><tr><td>Flammability (Red)</td><td>1</td></tr><tr><td>Reactivity (Yellow)</td><td>0</td></tr></table>		Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	1	Reactivity (Yellow)	0																						
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NOTES

(Continued on pages 3 and 4)

DMH

1,1-DIMETHYLHYDRAZINE

Common Synonyms UDMH Dimethylhydrazine anhydrous Dimethylhydrazine		Water liquid Colorless Fishy or ammonia-like odor
Avoid Contact with Liquid and Vapor. Keep people away. Wear chemical protective suit with self-contained breathing apparatus. Shut off ignition sources and call fire department. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Evacuate area in case of large discharge. Isolate and remove discharged material. Notify local health and pollution control agencies.		Floats and mixes with water.
Fire FLAMMABLE. POISONOUS GASES ARE PRODUCED WHEN HEATED. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear chemical protective suit with self-contained breathing apparatus. Flood discharge area with water. Extinguish with water.		
Exposure CALL FOR MEDICAL AID. VAPOR POISONOUS IF INHALED OR IF SKIN IS EXPOSED. Irritating to eyes. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. Will burn eyes. Remove contaminated clothing and shoes. Flush affected area with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.		
Water Pollution Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.		
1. RESPONSE TO DISCHARGE (See Response Methods Handbook CG 446-4) Issue warning - high flammability Restrict access Evacuate area Disperse and flush	2. LABELS  	
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Dimazine UDMH anhydrous Dimethylhydrazine 3.2 Coast Guard Competibility Classification: Not applicable 3.3 Chemical Formula: (CH ₃) ₂ N-NH ₂ 3.4 IMCO/United Nations Numerical Designation: 3.2 1163	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Sharp ammoniacal, fishy	
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Rubber gloves, boots, and apron; plastic face shield. Gas mask with ammonia (GMD) canister protects for 30 min. against 1% concentration; for longer periods or higher concentrations, use self-contained breathing apparatus. 5.2 Symptoms Following Exposure: Breathing of vapor causes pulmonary irritation; delayed gastric intestinal irritation, tremors, and convulsions. Contact with skin or mucous membranes causes chemical burns. Can be absorbed through skin to cause systemic intoxication and convulsions. 5.3 Treatment for Exposure: INITIAL ACTION: remove victim from contaminated area, give artificial respiration and oxygen if needed; watch for signs of pulmonary edema; enforce absolute rest. (See FIRST AID NO. 1) induce vomiting; hospitalize. SKIN OR EYES: flush with water and treat as alkaline burn. 5.4 Toxicity by Inhalation (Threshold Limit Value): 0.5 ppm 5.5 Short-Term Inhalation Limits: 100 ppm for 10 min.; 50 ppm for 30 min.; 30 ppm for 60 min. 5.6 Toxicity by Ingestion: Grade 3.1 LD ₅₀ 50 to 800 mg/kg (rat, mouse) 5.7 Late Toxicity: Data not available Mild anemia, upper respiratory irritation, and muscle tremors in dogs following chronic exposure. 5.8 Vapor (Gas) Irritant Characteristics: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high concentrations. 5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact and is very injurious to the eyes. 5.10 Odor Threshold: 6-14 ppm		

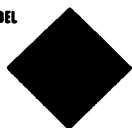
6. FIRE HAZARDS 6.1 Flash Point: 14°F (C) 6.2 Flammable Limits in Air: 2% - 95% 6.3 Fire Extinguishing Agents: Flood with water 6.4 Fire Extinguishing Agents Not to be Used: In large fires, water fog, carbon dioxide, and bicarbonate types may allow flashback and explosive re-ignition. 6.5 Special Hazards of Combustion Products: None 6.6 Behavior in Fire: Tends to re-ignite unless diluted with much water. 6.7 Ignition Temperature: 452-482°F 6.8 Electrical Hazard: Class E, Group D 6.9 Burning Rate: 1.8 mm/min	8. WATER POLLUTION 8.1 Aquatic Toxicity: Data not available 8.2 Waterway Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: Data not available																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: Dissolves, swells, and disintegrates many plastics 7.3 Stability During Transport: Stable below 1112°F 7.4 Neutralizing Agents for Acids and Caustics: Flush with water 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS EMC Corporation Organic Chemicals Division 633 Third Ave. New York, N.Y. 10012																																				
	10. SHIPPING INFORMATION 10.1 Grades or Purity: Propellant-grade 98% min. 10.2 Storage Temperature: Below 120°F 10.3 Inert Atmosphere: Inert 10.4 Volting: Data not available																																				
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook CG 446-3) A-P-Q-R-S	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 60.11 13.3 Boiling Point at 1 atm: 146.0°F = 63.3°C = 336.5°K 13.4 Freezing Point: -71°F = -57°C = 216°K 13.5 Critical Temperature: 480°F = 249°C = 522°K 13.6 Critical Pressure: 865 psia = 53.5 atm = 5.40 MN/m ² 13.7 Specific Gravity: 0.791 at 20°C (liquid) 13.8 Liquid Surface Tension: 28 dynes/cm = 0.028 N/m at 25°C 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: 2.1 13.11 Ratio of Specific Heats of Vapor (Gas): test 11.152 13.12 Latent Heat of Vaporization: 261 Btu/lb = 145 cal/g = 6.07 X 10 ³ J/kg 13.13 Heat of Combustion: -14,170 Btu/lb = -7870 cal/g = -329.3 X 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: test 1 = 30 Btu/lb = -10 cal/g = -0.6 X 10 ³ J/kg 13.16 Heat of Polymerization: Not pertinent																																				
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid 12.2 NAS Hazard Rating for Bulk Water Transportation: <table> <thead> <tr> <th>Category</th><th>Rating</th></tr> </thead> <tbody> <tr> <td>Fire</td><td>4</td></tr> <tr> <td>Health</td><td></td></tr> <tr> <td> Vapor Irritant</td><td>3</td></tr> <tr> <td> Liquid or Solid Irritant</td><td>4</td></tr> <tr> <td> Poisons</td><td>4</td></tr> <tr> <td>Water Pollution</td><td></td></tr> <tr> <td> Human Toxicity</td><td>4</td></tr> <tr> <td> Aquatic Toxicity</td><td>2</td></tr> <tr> <td> Acute Effect</td><td>2</td></tr> <tr> <td>Reactivity</td><td></td></tr> <tr> <td> Other Chemicals</td><td>4</td></tr> <tr> <td> Water</td><td>0</td></tr> <tr> <td> Self Reaction</td><td>4</td></tr> </tbody> </table> 12.3 NFPA Hazard Classifications: <table> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td><td>3</td></tr> <tr> <td>Flammability (Red)</td><td>3</td></tr> <tr> <td>Reactivity (Yellow)</td><td>1</td></tr> </tbody> </table>	Category	Rating	Fire	4	Health		Vapor Irritant	3	Liquid or Solid Irritant	4	Poisons	4	Water Pollution		Human Toxicity	4	Aquatic Toxicity	2	Acute Effect	2	Reactivity		Other Chemicals	4	Water	0	Self Reaction	4	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	3	Reactivity (Yellow)	1	
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ETA

ETHYL ACETATE

<p>Common Synonyms Acetic acid, ethyl ester Acetic ester Vinegar naphtha</p>	<p>Watery liquid Colorless Pleasant fruity odor</p> <p>Floats on water. Flammable, irritating vapor is produced.</p>
<p>Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
<p>Fire</p>	<p>FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>
<p>Exposure</p>	<p>CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled will cause headache, dizziness, nausea, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected area with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</p>
<p>Water Pollution</p>	<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning - high flammability Evacuate area Disperse and flush</p>	<p>2. LABEL</p> 
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 Synonyms: Acetic acid, ethyl ester Acetic ester Acetic ether Ethyl ethanoate</p> <p>3.2 Coast Guard Compatibility Classification: Ester</p> <p>3.3 Chemical Formula: CH₃COO C₂H₅</p> <p>3.4 IMCO/United Nations Numerical Designation: 1.2-1173</p>	<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid</p> <p>4.2 Color: Colorless</p> <p>4.3 Odor: Pleasant, fruity</p>
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Organic vapor canister or air mask; goggles or face shield</p> <p>5.2 Symptoms Following Exposure: Headache, irritation of respiratory passages and eyes, dizziness and nausea, weakness, loss of consciousness</p> <p>5.3 Treatment for Exposure: INHALATION: If victim is overcome, move him to fresh air immediately and call a physician; if breathing is irregular or stopped, start resuscitation and administer oxygen. EYES: flush with water for at least 15 min</p> <p>5.4 Toxicity by Inhalation (Threshold Limit Value): 400 ppm</p> <p>5.5 Short-Term Inhalation Limits: 1000 ppm for 15 min</p> <p>5.6 Toxicity by Ingestion: Grade 2, LD₅₀ 5 to 5 g/kg</p> <p>5.7 Late Toxicity: Data not available</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin</p> <p>5.10 Odor Threshold: 1 ppm</p>	

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 24°F (C = 55°F) O.C.</p> <p>6.2 Flammable Limits in Air: 2.2% - 9.0%</p> <p>6.3 Fire Extinguishing Agents: Alcohol foam, carbon dioxide or dry chemicals</p> <p>6.4 Fire Extinguishing Agents Not to be Used: Not pertinent</p> <p>6.5 Special Hazards of Combustion Products: Not pertinent</p> <p>6.6 Behavior in Fire: Not pertinent</p> <p>6.7 Ignition Temperature: 800°F</p> <p>6.8 Electrical Hazard: (Class I, group D)</p> <p>6.9 Burning Rate: 3.7 mm/min</p>	<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: Data not available</p> <p>8.2 Waterfowl Toxicity: Data not available</p> <p>8.3 Biological Oxygen Demand (BOD): (Theoretical) 66%, 5 days</p> <p>8.4 Food Chain Concentration Potential: None</p>																																				
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity with Water: No reaction</p> <p>7.2 Reactivity with Common Materials: No reaction</p> <p>7.3 Stability During Transport: Stable</p> <p>7.4 Neutralizing Agents for Acids and Caustics: Not pertinent</p> <p>7.5 Polymerization: Not pertinent</p> <p>7.6 Inhibitor of Polymerization: Not pertinent</p>	<p>9. SELECTED MANUFACTURERS</p> <p>1 Eastman Kodak Co. Tennessee Eastman Co., Div. Kingsport, Tenn. 37662</p> <p>2 Monsanto Co. Monsanto Industrial Chemicals Co. 800 North Lindbergh Blvd. St. Louis, Mo. 63166</p> <p>3 Union Carbide Corp. Chemicals and Plastics Div. 270 Park Ave. New York, N. Y. 10017</p>																																				
<p>11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-P-Q</p>	<p>10. SHIPPING INFORMATION</p> <p>10.1 Grades or Purity: 85-100%</p> <p>10.2 Storage Temperature: Ambient</p> <p>10.3 Inert Atmosphere: No requirement</p> <p>10.4 Venting: Open (flame arrester) or pressure/vacuum</p>																																				
<p>12. HAZARD CLASSIFICATIONS</p> <p>12.1 Code of Federal Regulations: Flammable liquid</p> <p>12.2 NAS Hazard Rating for Bulk Water Transportation:</p> <table data-bbox="893 1335 1141 1587"> <thead> <tr> <th>Category</th><th>Rating</th></tr> </thead> <tbody> <tr> <td>Fire</td><td>3</td></tr> <tr> <td>Health</td><td></td></tr> <tr> <td> Vapor Irritant</td><td>1</td></tr> <tr> <td> Liquid or Solid Irritant</td><td>1</td></tr> <tr> <td> Poisons</td><td>2</td></tr> <tr> <td>Water Pollution</td><td></td></tr> <tr> <td> Human Toxicity</td><td>1</td></tr> <tr> <td> Aquatic Toxicity</td><td>2</td></tr> <tr> <td> Aesthetic Effect</td><td>2</td></tr> <tr> <td>Reactivity</td><td></td></tr> <tr> <td> Other Chemicals</td><td>1</td></tr> <tr> <td> Water</td><td>0</td></tr> <tr> <td> Self-Reaction</td><td>0</td></tr> </tbody> </table> <p>12.3 NFPA Hazard Classifications:</p> <table data-bbox="893 1598 1141 1671"> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td><td>1</td></tr> <tr> <td>Flammability (Red)</td><td>3</td></tr> <tr> <td>Reactivity (Yellow)</td><td>0</td></tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	1	Flammability (Red)	3	Reactivity (Yellow)	0	<p>13. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>13.1 Physical State at 15°C and 1 atm: Liquid</p> <p>13.2 Molecular Weight: 88.11</p> <p>13.3 Boiling Point at 1 atm: 171°F = 77°C = 350°K</p> <p>13.4 Freezing Point: -117°F = -83°C = 190°K</p> <p>13.5 Critical Temperature: 482°F = 250°C = 523°K</p> <p>13.6 Critical Pressure: 558 psia = 38 atm = 3.8 MN/m²</p> <p>13.7 Specific Gravity: 0.902 at 20°C (liquid)</p> <p>13.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 20°C</p> <p>13.9 Liquid-Water Interfacial Tension: 6.79 dynes/cm = 0.00679 N/m at 30°C</p> <p>13.10 Vapor (Gas) Specific Gravity: 3.0</p> <p>13.11 Ratio of Specific Heats of Vapor (Gas): 1.080</p> <p>13.12 Latent Heat of Vaporization: 158 Btu/lb = 87.6 cal/g = 3.67 × 10⁵ J/kg</p> <p>13.13 Heat of Combustion: -10,110 Btu/lb = -5616 cal/g = -235.1 × 10³ J/kg</p> <p>13.14 Heat of Decomposition: Not pertinent</p> <p>13.15 Heat of Solution: Not pertinent</p> <p>13.16 Heat of Polymerization: Not pertinent</p>
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REVISED 1978

6. FIRE HAZARDS 6.1 Flash Point: 55°F (C) 64°F (C) 6.2 Flammable Limits in Air: 3.3% - 19% 6.3 Fire Extinguishing Agents: Carbon dioxide, dry chemical, water spray, alcohol foam 6.4 Fire Extinguishing Agents Not to be Used: None 6.5 Special Hazards of Combustion Products: None 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 639°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 3.9 mm/min		8. WATER POLLUTION 8.1 Aquatic Toxicity: 250 ppm/6 hr/goldfish/lethal/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 125% > days, 44.2% (theor.), 5 days, 71.2% (theor.), 20 days 8.4 Food Chain Concentration Potential: None																																					
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent		9. SELECTED MANUFACTURERS 1. Commercial Solvents Corp. 245 Park Ave. New York, N.Y. 10017 2. National Distillers and Chemical Corp. U.S. Industrial Chemicals Co. Division Tuscola, Ill. 61953 3. Publi-tek Industries, Inc. 1429 Walnut St. Philadelphia, Pa. 19102																																					
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-P-Q-R-S		10. SHIPPING INFORMATION 10.1 Grade or Purity: Anhydrous (200 proof), 190 proof, specially denatured, completely denatured 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open (flame arrester or pressure vacuum)																																					
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid 12.2 NAS Hazard Rating for Bulk Water Transportation: <table> <tr> <th>Category</th><th>Rating</th></tr> <tr> <td>Fire</td><td>3</td></tr> <tr> <td>Health</td><td></td></tr> <tr> <td> Vapor Irritant</td><td>1</td></tr> <tr> <td> Liquid or Solid Irritant</td><td>0</td></tr> <tr> <td> Poisons</td><td>1</td></tr> <tr> <td>Water Pollution</td><td></td></tr> <tr> <td> Human Toxicity</td><td>1</td></tr> <tr> <td> Aquatic Toxicity</td><td>1</td></tr> <tr> <td> Aesthetic Effect</td><td>1</td></tr> <tr> <td>Reactivity</td><td></td></tr> <tr> <td> Other Chemicals</td><td>2</td></tr> <tr> <td> Water</td><td>0</td></tr> <tr> <td> Self-Reaction</td><td>0</td></tr> </table> 12.3 NFPA Hazard Classifications: <table> <tr> <th>Category</th><th>Classification</th></tr> <tr> <td>Health Hazard (Blue)</td><td>0</td></tr> <tr> <td>Flammability (Red)</td><td>3</td></tr> <tr> <td>Reactivity (Yellow)</td><td>0</td></tr> </table>		Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	0	Poisons	1	Water Pollution		Human Toxicity	1	Aquatic Toxicity	1	Aesthetic Effect	1	Reactivity		Other Chemicals	2	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	0	Flammability (Red)	3	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 46.07 13.3 Boiling Point at 1 atm: 172.9°F = 78.3°C = 351.5°K 13.4 Freezing Point: -173°F = -114°C = 159°K 13.5 Critical Temperature: 469.6°F = 243.1°C = 516.3°K 13.6 Critical Pressure: 926 psia = 63.0 atm = 6.38 MPa (m) 13.7 Specific Gravity: 0.790 at 20°C (liquids) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: 1.6 13.11 Ratio of Specific Heats of Vapor (Gas): 1.128 13.12 Latent Heat of Vaporization: 360 Btu/lb = 200 cal/g = 8.37×10^3 J/kg 13.13 Heat of Combustion: -11,570 Btu/lb = 6425 cal/g = -268.8×10^3 J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: -99 Btu/lb = -55 cal/g = -2.3×10^3 J/kg 13.16 Heat of Polymerization: Not pertinent	
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Aquatic Toxicity	1																																						
Aesthetic Effect	1																																						
Reactivity																																							
Other Chemicals	2																																						
Water	0																																						
Self-Reaction	0																																						
Category	Classification																																						
Health Hazard (Blue)	0																																						
Flammability (Red)	3																																						
Reactivity (Yellow)	0																																						

(Continued on pages 4 and 6)

NOTES

EGL

ETHYLENE GLYCOL

Common Synonyms Glycol Monoethylene glycol 1,2-Ethandiol		Thick liquid Sinks and mixes with water.	Colorless	Odorless
Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.				
Fire	Combustible. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.			
Exposure	CALL FOR MEDICAL AID. LIQUID Irritating to skin and eyes. If swallowed, will cause loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.			
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes:			
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446-4)</small> Disperse and flush.		2. LABELS No hazard label required by Code of Federal Regulations.		
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: 1,2-Dihydroxyethane 1,2-Ethandiol Ethylene dihydrate Glycol Monoethylene glycol 3.2 Coast Guard Compatibility Classification: Glycol 3.3 Chemical Formula: HOCH ₂ CH ₂ OH 3.4 IMCO United Nations Numerical Designation: Not listed		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Slight odor		
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Goggles, shower and eye bath 5.2 Symptoms Following Exposure: Inhalation of vapor is not hazardous. Ingestion causes stupor or coma, sometimes leading to fatal kidney injury. 5.3 Treatment for Exposure: INGESTION: induce vomiting and call a physician. SKIN AND EYES: flush with water. 5.4 Toxicity by Inhalation (Threshold Limit Value): 100 ppm 5.5 Short-Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion: Grade I, LD ₅₀ 5 to 15 g/kg (rat, guinea pig, mouse) 5.7 Lethal Toxicity: Fatal kidney injury may result if ingested. 5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat. 5.9 Liquid or Solid Irritant Characteristics: No appreciable hazard. Practically harmless to the skin. 5.10 Odor Threshold: Not pertinent				


6. FIRE HAZARDS 6.1 Flash Point: 240°F (117°C) (232°F (112°C)) 6.2 Flammable Limits in Air: LFL = 3.2%, UFL not listed 6.3 Fire Extinguishing Agents: Water for alcohol foam, carbon dioxide, or dry chemical. 6.4 Fire Extinguishing Agents Not to be Used: Water or foam may cause foaming. 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 755°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Unknown		8. WATER POLLUTION 8.1 Aquatic Toxicity: >100 ppm: 48 hr shrimp LC ₅₀ salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 12% (theoretical) day, 78% (theoretical) 20 days 8.4 Food Chain Concentration Potential: None																																					
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent		9. SELECTED MANUFACTURERS 1. Dow Chemical Co. Midland, Mich. 48640 2. PPG Industries, Inc. Chemical Division Guayama, Puerto Rico 00856 3. Union Carbide Corp. Chemicals and Plastics Division 270 Park Ave. New York, N.Y. 10017																																					
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-P-Q		10. SHIPPING INFORMATION 10.1 Grades or Purity: Industrial grade, low conductivity grade 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open (flame arrester)																																					
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Not listed 12.2 NAS Hazard Rating for Bulk Water Transportation: <table><tr><th>Category</th><th>Rating</th></tr><tr><td>Fire</td><td>1</td></tr><tr><td>Health</td><td></td></tr><tr><td>Vapor Irritant</td><td>0</td></tr><tr><td>Liquid or Solid Irritant</td><td>0</td></tr><tr><td>Poisons</td><td>1</td></tr><tr><td>Water Pollution</td><td></td></tr><tr><td>Human Toxicity</td><td>2</td></tr><tr><td>Aquatic Toxicity</td><td>1</td></tr><tr><td>Aesthetic Effect</td><td>1</td></tr><tr><td>Reactivity</td><td></td></tr><tr><td>Other Chemicals</td><td>2</td></tr><tr><td>Water</td><td>0</td></tr><tr><td>Self-Reaction</td><td>0</td></tr></table> 12.3 NIPIA Hazard Classifications: <table><tr><th>Category</th><th>Classification</th></tr><tr><td>Health Hazard (Blue)</td><td>1</td></tr><tr><td>Flammability (Red)</td><td>1</td></tr><tr><td>Reactivity (Yellow)</td><td>0</td></tr></table>		Category	Rating	Fire	1	Health		Vapor Irritant	0	Liquid or Solid Irritant	0	Poisons	1	Water Pollution		Human Toxicity	2	Aquatic Toxicity	1	Aesthetic Effect	1	Reactivity		Other Chemicals	2	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	1	Flammability (Red)	1	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 62.07 13.3 Boiling Point at 1 atm: 387.7°F = 197.6°C = 470.8°K 13.4 Freezing Point: 8.6°F = -13°C = 260°K 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 1.115 at 20°C (liquid) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): 1.095 13.12 Latent Heat of Vaporization: 444 Btu/lb = 191 cal/g = 8.00 × 10 ³ J/kg 13.13 Heat of Combustion: -7259 Btu/lb = -4033 cal/g = -168.9 × 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: (solid) -20 Btu/lb = -12 cal/g = -0.5 × 10 ³ J/kg 13.16 Heat of Polymerization: Not pertinent	
Category	Rating																																						
Fire	1																																						
Health																																							
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<i>(Continued on pages 1 and 6)</i>																																							
NOTES																																							

(Continued on pages 1 and 6)

GAT

GASOLINES: AUTOMOTIVE

(< 4.23g lead/gal)

Common Synonyms	Watery liquid Colorless to pale brown or pink Gasoline odor Floats on water. Flammable, irritating vapor is produced.
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headache, difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea or vomiting. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4.) Evacuate warning area. Evacuate area. Disperse and flush.	2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Motor-pump Petrol 3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures 3.3 Chemical Formula: (Mixture of hydrocarbons) 3.4 IMCO United Nations Numerical Designation: 1.1 (20)	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless to brown 4.3 Odor: Gasoline
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Protective goggles, gloves. 5.2 Symptoms Following Exposure: Irritation of mucous membrane and stimulation followed by depression of central nervous system. Breathing of vapors may also cause dizziness, headache, and incoordination or, in more severe cases, anesthesia and respiratory arrest. If liquid enters lungs, it will cause severe irritation, conjunctive, pulmonary edema, and later signs of bronchopneumonia and pneumonia. Swallowing it will cause irregular heartbeat. 5.3 Treatment for Exposure: INHALATION: Inquire on respiration and administer oxygen; enforce bed rest at least 48 hours. (NOS) STOMACH: If liquid is vomited, stomach should be lavaged (do not force appreciable quantities); swallow. IF EYES: Wash with copious quantities of water. SKIN: Wipe off and wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): No single TLV applies. 5.5 Short-Term Inhalation Limits: 500 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 2.1 D (0.1 to 5.0 kg). 5.7 Late Toxicity: None. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 0.25 ppm.	

6. FIRE HAZARDS 6.1 Flash Point: -16.1°C (-1°F) 6.2 Flammable Limits in Air: 1.4% - 7.4% 6.3 Fire Extinguishing Agents: Foams, carbon dioxide, dry chemical. 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 6.5 Special Hazards of Combustion Products: None. 6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back. 6.7 Ignition Temperature: 853.1°C 6.8 Electrical Hazard: Class I, Group D. 6.9 Burning Rate: 4 mm/min.	8. WATER POLLUTION 8.1 Aquatic Toxicity: 90 ppm, 24 hr, juvenile American shad, 14 mg/l, fresh water. 90 mg/l, 24 hr, juvenile American shad, 14 mg/l, salt water. 8.2 Waterflow Toxicity: Data not available. 8.3 Biological Oxygen Demand (BOD): 4.0, 5 days. 8.4 Food Chain Concentration Potential: None.																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction. 7.2 Reactivity with Common Materials: No reaction. 7.3 Stability During Transport: Stable. 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent. 7.5 Polymerization: Not pertinent. 7.6 Inhibitor of Polymerization: Not pertinent.	9. SELECTED MANUFACTURERS 1. Exxon Co. 30 Rockefeller Plaza New York, N.Y. 10020 2. Shell Oil Co. 1 Shell Plaza Houston, Texas 77001 3. Sun Oil Co. St. Davids, Pa. 19087																																				
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3.) A-1-A-V-W 12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid. 12.2 NAS Hazard Rating for Bulk Water Transportation: <table data-bbox="949 1372 1172 1606"> <thead> <tr> <th>Category</th><th>Rating</th></tr> </thead> <tbody> <tr><td>Fire</td><td>3</td></tr> <tr><td>Health</td><td></td></tr> <tr><td>Vapor Irritant</td><td>1</td></tr> <tr><td>Liquid or Solid Irritant</td><td>1</td></tr> <tr><td>Poisons</td><td>2</td></tr> <tr><td>Water Pollution</td><td></td></tr> <tr><td>Human Toxicity</td><td>1</td></tr> <tr><td>Aquatic Toxicity</td><td>2</td></tr> <tr><td>Aesthetic Effect</td><td>2</td></tr> <tr><td>Reactivity</td><td></td></tr> <tr><td>Other Chemicals</td><td>0</td></tr> <tr><td>Water</td><td>0</td></tr> <tr><td>Self-Reaction</td><td>0</td></tr> </tbody> </table> 12.3 NFPA Hazard Classifications: <table data-bbox="949 1627 1172 1713"> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr><td>Health Hazard (Blue)</td><td>3</td></tr> <tr><td>Flammability (Red)</td><td>3</td></tr> <tr><td>Reactivity (Yellow)</td><td>0</td></tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity		Other Chemicals	0	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	3	Reactivity (Yellow)	0	10. SHIPPING INFORMATION 10.1 Grades or Purity: Various octane ratings; military specifications. 10.2 Storage Temperature: Ambient. 10.3 Inert Atmosphere: No requirement. 10.4 Venting: Open flame, arrestor of pressure, vacuum. 13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid. 13.2 Molecular Weight: Not pertinent. 13.3 Boiling Point at 1 atm: 140 - 200°C = 284 - 392°F. 13.4 Freezing Point: Not pertinent. 13.5 Critical Temperature: Not pertinent. 13.6 Critical Pressure: Not pertinent. 13.7 Specific Gravity: 0.7321 at 20°C (liquid). 13.8 Liquid Surface Tension: 19 - 23 dynes/cm = 0.019 - 0.023 N/m at 20°C. 13.9 Liquid-Water Interfacial Tension: 49 - 51 dynes/cm = 0.049 - 0.051 N/m at 20°C. 13.10 Vapor (Gas) Specific Gravity: 1.4. 13.11 Ratio of Specific Heats of Vapor (Gas): 1.054. 13.12 Latent Heat of Vaporization: 400 - 450 Btu/lb = 7.1 - 8.1 cal/g = 3.0 - 3.4 X 10 ⁴ J/kg. 13.13 Heat of Combustion: -18,720 Btu/lb = -10,400 cal/g = -43.1 X 10 ⁴ J/kg. 13.14 Heat of Decomposition: Not pertinent. 13.15 Heat of Solution: Not pertinent. 13.16 Heat of Polymerization: Not pertinent.
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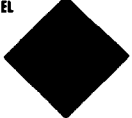
NOTES

REVISED 1978

GAV


GASOLINES: AVIATION

(< 4.86g lead/gal)

Common Synonyms	Watery liquid. Red, blue, green, brown or purple. Floats on water. Flammable, irritating vapor is produced.
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled will cause dizziness, headache, difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea or vomiting. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning - high flammability. Evacuate area. Disperse and flush.	2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: No common synonyms. 3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures. 3.3 Chemical Formula: Not pertinent. 3.4 IMCO United Nations Numerical Designation: 111201.	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid. 4.2 Color: Red, blue, green, brown, purple. 4.3 Odor: Gasoline.
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Protective goggles, gloves. 5.2 Symptoms Following Exposure: INHALATION causes irritation of upper respiratory tract, central nervous system stimulation followed by depression of varying degrees ranging from dizziness, headache, and incoordination to anesthesia, coma, and respiratory arrest. Irregular heartbeat is dangerous complication. ASPIRATION causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema. Later signs - bronchopneumonia and pneumonia, acute onset of central nervous system excitement followed by depression. INGESTION causes irritation of mucous membranes of throat, esophagus, and stomach, stimulation followed by depression of central nervous system, irregular heartbeat. 5.3 Treatment for Exposure: Seek medical attention. INHALATION: maintain respiration, give oxygen if needed. ASPIRATION: encourage rest, administer oxygen. INGESTION: do NOT induce vomiting, lavage carefully if appreciable quantity was ingested, guard against aspiration into lungs. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): No single TLV applicable. 5.5 Short-Term Inhalation Limits: 500 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 2, LD ₅₀ 0.5 to 5 g/kg. 5.7 Late Toxicity: None.	

6. FIRE HAZARDS 6.1 Flash Point: -50°F (-45°C) 6.2 Flammable Limits in Air: 1.2% - 7.1% 6.3 Fire Extinguishing Agents: Foam, carbon dioxide, dry chemical. 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 6.5 Special Hazards of Combustion Products: None. 6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flashback. 6.7 Ignition Temperature: 824°F 6.8 Electrical Hazard: Class C, group I. 6.9 Burning Rate: 4 mm/min.	8. WATER POLLUTION 8.1 Aquatic Toxicity: 90 ppm/24 hr. juvenile American flounder, fresh water. 91 ppm/24 hr. juvenile American flounder, salt water. 8.2 Waterfowl Toxicity: Data not available. 8.3 Biological Oxygen Demand (BOD): 8 - 15 days. 8.4 Food Chain Concentration Potential: None.																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction. 7.2 Reactivity with Common Materials: No reaction. 7.3 Stability During Transport: Stable. 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent. 7.5 Polymerization: Not pertinent. 7.6 Inhibitor of Polymerization: Not pertinent.	9. SELECTED MANUFACTURERS 1. Exxon Co. 30 Rockefeller Plaza New York, N.Y. 10020 2. Shell Oil Co. 1 Shell Plaza Houston, Texas 77001 3. Sun Oil Co. St. Davids, Pa. 19087																																				
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-1) A-T-L-A-W	10. SHIPPING INFORMATION 10.1 Grades or Purity: Grade 80/87, 100/130, and 115/145. Specific gravity: 0.71-0.72. 10.2 Storage Temperature: Ambient. 10.3 Inert Atmosphere: Not required. 10.4 Venting: Open flame and/or hot pressure/vacuum.																																				
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid. 12.2 NAS Hazard Rating for Bulk Water Transportation: <table data-bbox="966 1344 1197 1585"> <thead> <tr> <th>Category</th><th>Rating</th></tr> </thead> <tbody> <tr><td>Fire</td><td>3</td></tr> <tr><td>Health</td><td></td></tr> <tr><td>Vapor Irritant</td><td>1</td></tr> <tr><td>Liquid or Solid Irritant</td><td>1</td></tr> <tr><td>Poisons</td><td>5</td></tr> <tr><td>Water Pollution</td><td></td></tr> <tr><td>Human Toxicity</td><td>1</td></tr> <tr><td>Aquatic Toxicity</td><td>2</td></tr> <tr><td>Aesthetic Effect</td><td>2</td></tr> <tr><td>Reactivity</td><td></td></tr> <tr><td>Other Chemicals</td><td>0</td></tr> <tr><td>Water</td><td>0</td></tr> <tr><td>Self-Reaction</td><td>0</td></tr> </tbody> </table> 12.3 MFPA Hazard Classifications: <table data-bbox="966 1606 1197 1680"> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr><td>Health Hazard Effect</td><td>1</td></tr> <tr><td>Flammability (Red)</td><td>3</td></tr> <tr><td>Reactivity (Yellow)</td><td>0</td></tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	5	Water Pollution		Human Toxicity	1	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity		Other Chemicals	0	Water	0	Self-Reaction	0	Category	Classification	Health Hazard Effect	1	Flammability (Red)	3	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid. 13.2 Molecular Weight: Not pertinent. 13.3 Boiling Point at 1 atm: 160 - 180°F (-10 - 10°C). 13.4 Freezing Point: -50°F (-45°C) to -20°F (-8°C). 13.5 Critical Temperature: Not pertinent. 13.6 Critical Pressure: Not pertinent. 13.7 Specific Gravity: 0.711 at 15°C (liquid). 13.8 Liquid Surface Tension: 29.23 dynes/cm at 0.029 - 0.023 N/m at 20°C. 13.9 Liquid-Water Interfacial Tension: 49.5 dynes/cm at 0.049 - 0.035 N/m at 20°C. 13.10 Vapor (Gas) Specific Gravity: 1.4. 13.11 Ratio of Specific Heats of Vapor (Gas): 1.04 to 1.04. 13.12 Latent Heat of Vaporization: 30 - 450 Btu/lb = 71 - 81 kcal/g. 13.13 Heat of Combustion: -18,720 Btu/lb = -10,400 cal/g = -43.4 x 10 ³ kJ/kg. 13.14 Heat of Decomposition: Not pertinent. 13.15 Heat of Solution: Not pertinent. 13.16 Heat of Polymerization: Not pertinent.
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Flammability (Red)	3																																				
Reactivity (Yellow)	0																																				
5. HEALTH HAZARDS (Cont'd.) 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 0.25 ppm.																																					

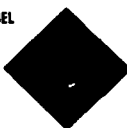
(Continued on pages 1 and 6)

Common Synonyms		Watery liquid	Colorless	Gasoline odor
Floats on water. Flammable, irritating vapor is produced.				
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.				
Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.			
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headache, difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea and vomiting. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.			
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.			
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446.4.)</small> Issue warning - high flammability. Evacuate area. Dispose and flush.		2. LABEL 		
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: No common synonyms. 3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures. 3.3 Chemical Formula: Not pertinent. 3.4 IMCO United Nations Numerical Designation: 1332 (20).		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid. 4.2 Color: Colorless. 4.3 Odor: Gasoline.		
5. HEALTH HAZARDS Personal Protective Equipment: Protective goggles, gloves. Symptoms Following Exposure: INHALATION causes irritation of upper respiratory tract, coughing, and may be followed by depression of varying degrees ranging from mild to severe. INGESTION causes irritation of the oral cavity and respiratory arrest. IRRITATION causes severe eye irritation with coughing and difficulty breathing. ASPIRATION causes severe lung irritation with coughing and difficulty breathing. SKIN causes developing pulmonary edema. Late signs of irritation include: central nervous system excitement, hyperreflexia, and convulsions. SKIN causes irritation of the skin. SKIN causes irritation of the skin.				
Treatment for Exposure: INHALATION: mount an respirator, give first aid, and move to fresh air. EYES: flush with water. INGESTION: do not induce vomiting. A vomited, guard against further ingestion. SKIN: wipe off and wash.				
Threshold Limit Value (TLV) Not applicable.				


6. FIRE HAZARDS		8. WATER POLLUTION																													
6.1 Flash Point: (a) $< 0^{\circ}\text{F}$ ($< 0^{\circ}\text{C}$) (b) 0.7°F (0.4°C)		8.1 Aquatic Toxicity: 90 ppm/24 hr/juvenile American shad 11 mg/fresh water 91 ppm/24 hr/juvenile American shad 11 mg/salt water																													
6.2 Flammable Limits in Air: (a) 1.1% - 8.7%		8.2 Waterfowl Toxicity: Data not available																													
6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide		8.3 Ecological Oxygen Demand (BOD): 8% 5 days																													
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective		8.4 Food Chain Concentration Potential: None																													
6.5 Special Hazards of Combustion Products: None																															
6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back		9. SELECTED MANUFACTURERS																													
6.7 Ignition Temperature: Data not available		1. Exxon Co. 40 Rockefeller Plaza New York, N.Y. 10020																													
6.8 Electrical Hazard: Class I, group D		2. Shell Oil Co. 1 Shell Plaza Houston, Tex. 77001																													
6.9 Burning Rate: 4 mm/min		3. Sun Oil Co. St. Davids, Pa. 19087																													
7. CHEMICAL REACTIVITY																															
7.1 Reactivity with Water: No reaction																															
7.2 Reactivity with Common Materials: No reaction																															
7.3 Stability During Transport: Stable																															
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent																															
7.5 Polymerization: Not pertinent																															
7.6 Inhibitor of Polymerization: Not pertinent																															
		10. SHIPPING INFORMATION																													
		10.1 Grades or Purity: Composition varies with range of distillation temperatures used																													
		10.2 Storage Temperature: Ambient																													
		10.3 Inert Atmosphere: No requirement																													
		10.4 Venting: Open flame arrester for pressure vacuum																													
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446.3.) A-T-C-A-W		13. PHYSICAL AND CHEMICAL PROPERTIES																													
		13.1 Physical State at 25°C and 1 atm: Liquid																													
		13.2 Molecular Weight: Not pertinent																													
		13.3 Boiling Point at 1 atm: 58.2°C (135°F) $\pm 14.1^{\circ}\text{C}$ ($\pm 25^{\circ}\text{F}$) 40% K																													
		13.4 Freezing Point: Not pertinent																													
		13.5 Critical Temperature: Not pertinent																													
		13.6 Critical Pressure: Not pertinent																													
		13.7 Specific Gravity: 0.71 - 0.75 at 15°C (liquid)																													
		13.8 Liquid Surface Tension: 19 - 23 dyne/cm ± 10.09 - 10.23 N/m at 20°C																													
		13.9 Liquid-Water Interfacial Tension: 40 - 50 dyne/cm ± 10.09 - 10.23 N/m at 20°C																													
		13.10 Vapor (Gas) Specific Gravity: 3.4																													
		13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent																													
		13.12 Latent Heat of Vaporization: 100 - 150 Btu/lb ± 21 - 31 cal/g ± 10 - 14 kJ/kg																													
		13.13 Heat of Combustion: $-18,720$ Btu/lb $\pm 10,400$ cal/g ± 43.4 kJ/kg																													
		13.14 Heat of Decomposition: Not pertinent																													
		13.15 Heat of Solution: Not pertinent																													
		13.16 Heat of Polymerization: Not pertinent																													
12. HAZARD CLASSIFICATIONS																															
12.1 Code of Federal Regulations: Flammable liquid																															
12.2 NAS Hazard Rating for Bulk Water Transportation:																															
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12.3 NFPA Hazard Classifications:																															
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		Continued on pages 1 and 2																													
5. HEALTH HAZARD (Cont'd.)																															
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. If effect is temporary																															
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin																															
5.10 Odor Threshold: 0.25 ppm																															

GRF

GASOLINE BLENDING STOCKS: REFORMATES

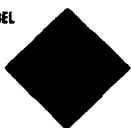
Common Synonyms		Watery liquid	Colorless	Gasoline odor																																				
		Floats on water. Flammable, irritating vapor is produced.																																						
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.																																								
Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.																																							
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled will cause dizziness, headache, difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea or vomiting. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.																																							
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.																																							
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG #46-3)</small> Issue warning - high flammability Evacuate area Disperse and flush		2. LABEL 																																						
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: No common synonyms 3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures 3.3 Chemical Formula: Not pertinent 3.4 IMCO/United Nations Numerical Designation: 3.1, 12/1203		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Gasoline																																						
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Protective goggles, gloves 5.2 Symptoms Following Exposure: INHALATION causes irritation of upper respiratory tract, central nervous system stimulation followed by depression of varying degrees ranging from dizziness, headache, and incoordination to anesthesia, coma, and respiratory arrest; irregular heartbeat is dangerous complication. ASPIRATION causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema; later, signs of bronchopneumonia and pneumonitis; acute onset of central nervous system followed by depression. INGESTION causes irritation of mucous membranes of throat, esophagus, and stomach; stimulation followed by depression of central nervous system; irregular heartbeat. 5.3 Treatment for Exposure: Seek medical attention. INHALATION: maintain respiration, give oxygen if needed. ASPIRATION: enforce bed rest, administer oxygen. INGESTION: do NOT induce vomiting; lavage carefully if appreciable quantity was ingested; guard against aspiration into lungs. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): No single TLV applicable 5.5 Short-Term Inhalation Limits: 500 ppm for 30 min 5.6 Toxicity by Ingestion: Grade 2.1 Data 5 to 5 g/kg 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.																																								
6. FIRE HAZARDS 6.1 Flash Point: (a) 50°F (10°C) (b) 0°F (-18°C) 6.2 Flammable Limits in Air: (a) 1.1% - 8.7% 6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective 6.5 Special Hazards of Combustion Products: None 6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flashback 6.7 Ignition Temperature: Data not available 6.8 Electrical Hazard: Class I, group D 6.9 Burning Rate: 4 mm/min																																								
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent																																								
8. WATER POLLUTION 8.1 Aquatic Toxicity: 90 ppm, 24 hr, acute, American fish 11 mg, fresh water 91 ppm, 24 hr, acute, American fish 11 mg, salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 8 - 5 days 8.4 Food Chain Concentration Potential: None																																								
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10. SHIPPING INFORMATION 10.1 Grades or Purity: Composition varies with range of distillation temperatures used 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open flame or restriction pressure/vacuum																																								
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5. HEALTH HAZARDS (Cont'd.) 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin 5.10 Odor Threshold: 0.25 ppm																																								

GASOLINES: CASINGHEAD

Common Synonyms		Watery liquid	Colorless	Gasoline odor
		Floats on water. Flammable, irritating vapor is produced.		
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.				
<div>Fire</div>	<div>FLAMMABLE.</div> <div>Flashback along vapor trail may occur.</div> <div>Vapor may explode if ignited in an enclosed area.</div> <div>Extinguish with dry chemical, foam or carbon dioxide.</div> <div>Water may be ineffective on fire.</div> <div>Cool exposed containers with water.</div>			
<div>Exposure</div>	<div>CALL FOR MEDICAL AID.</div> <div>VAPOR</div> <div>Irritating to eyes, nose and throat.</div> <div>If inhaled will cause dizziness, headache, difficult breathing or loss of consciousness.</div> <div>Move to fresh air.</div> <div>If breathing has stopped, give artificial respiration.</div> <div>If breathing is difficult, give oxygen.</div> <div>LIQUID</div> <div>Irritating to skin and eyes.</div> <div>If swallowed, will cause nausea or vomiting.</div> <div>Flush affected areas with plenty of water.</div> <div>IF IN EYES, hold eyelids open and flush with plenty of water.</div> <div>IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</div> <div>DO NOT INDUCE VOMITING.</div>			
<div>Water Pollution</div>	<div>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.</div> <div>Fouling to shoreline.</div> <div>May be dangerous if it enters water intakes.</div> <div>Notify local health and wildlife officials.</div> <div>Notify operators of nearby water intakes.</div>			
<div>1. RESPONSE TO DISCHARGE</div> <div>(See Response Methods Handbook, CG 446-4)</div> <div>Issue warning - high flammability</div> <div>Evacuate area</div> <div>Disperse and flush</div>		<div>2. LABEL</div> <div></div>		
<div>3. CHEMICAL DESIGNATIONS</div> <div>3.1 Synonyms: Natural gasoline</div> <div>3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures</div> <div>3.3 Chemical Formula: Not pertinent</div> <div>3.4 IMCO United Nations Numerical Designation: 311229</div>		<div>4. OBSERVABLE CHARACTERISTICS</div> <div>4.1 Physical State (as shipped): Liquid</div> <div>4.2 Color: Colorless</div> <div>4.3 Odor: Gasoline</div>		
<div>5. HEALTH HAZARDS</div> <div>5.1 Personal Protective Equipment: Protective goggles, gloves</div> <div>5.2 Symptoms Following Exposure: INHALATION causes irritation of upper respiratory tract, central nervous system stimulation followed by depression of varying degrees ranging from dizziness, headache, and incoordination to anesthesia, coma, and respiratory arrest. Irregular heartbeat is dangerous complication. ASPIRATION causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema. Later signs of bronchopneumonia and pneumonia. acute onset of central nervous system excitement followed by depression. INGESTION causes irritation of mucous membranes of throat, esophagus, and stomach stimulation followed by depression of central nervous system, irregular heartbeat</div> <div>5.3 Treatment for Exposure: Seek medical attention. INHALATION: maintain respiration, give oxygen if needed. ASPIRATION: enforce bed rest, administer oxygen. INGESTION: do NOT induce vomiting. Lavage carefully if appreciable quantity was ingested, guard against aspiration into lungs. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water.</div> <div>5.4 Toxicity by Inhalation (Threshold Limit Value): No single TLV applicable</div> <div>5.5 Short-Term Inhalation Limits: 500 ppm for 30 min</div> <div>5.6 Toxicity by Ingestion: Grade 2 LD50 3.0 g/kg</div> <div>5.7 Late Toxicity: None</div>				


6. FIRE HAZARDS 6.1 Flash Point: <10°F (0°C) 6.2 Flammable Limits in Air: 1.1% - 7.1% 6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective 6.5 Special Hazards of Combustion Products: None 6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back 6.7 Ignition Temperature: Data not available 6.8 Electrical Hazard: Class I, group D 6.9 Burning Rate: 4 mm/min		8. WATER POLLUTION 8.1 Aquatic Toxicity: 90 ppm/24 hr juvenile American shad 11 mg/fresh water 91 ppm/24 hr juvenile American shad 11 mg/salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 83, 5 days 8.4 Food Chain Concentration Potential: None																													
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(Continued on pages 5 and 6)

Common Synonyms		Watery liquid	Colorless	Gasoline odor
Floats on water. Flammable, irritating vapor is produced.				
<p>Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>				
Fire		<p>FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>		
Exposure		<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headaches, difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Irritating to skin and eyes. If swallowed, will cause nausea or vomiting. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p> <p>Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning - high flammability Evacuate area Disperse and flush</p>		<p>2. LABEL</p> 		
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 Synonyms: No common synonyms</p> <p>3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures</p> <p>3.3 Chemical Formula: Not pertinent</p> <p>3.4 IMCO/United Nations Numerical Designation: 32/1215</p>		<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid</p> <p>4.2 Color: Colorless</p> <p>4.3 Odor: Gasoline</p>		
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Protective goggles, gloves</p> <p>5.2 Symptoms Following Exposure: INHALATION: causes irritation of upper respiratory tract, central nervous system stimulation followed by depression of varying degrees ranging from dizziness, headache, and incoordination to anesthesia, coma, and respiratory arrest, irregular heartbeat is dangerous complication. ASPIRATION: causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema. Later, signs of bronchopneumonia and pneumonitis; acute onset of central nervous system excitement followed by depression. INGESTION: causes irritation of mucous membranes of throat, esophagus, and stomach; stimulation followed by depression of central nervous system, irregular heartbeat.</p> <p>5.3 Treatment for Exposure: Seek medical attention. INHALATION: maintain respiration, give oxygen if needed. ASPIRATION: enforce bed rest, administer oxygen. INGESTION: do NOT induce vomiting, lavage carefully if appreciable quantity was ingested, guard against aspiration into lungs. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water.</p> <p>5.4 Toxicity by Inhalation (Threshold Limit Value): No single TLV applicable</p> <p>5.5 Short-Term Inhalation Limits: 500 ppm for 30 min</p> <p>5.6 Toxicity by Ingestion: Grade 2, LD₅₀ 0.5 to 5 g/kg</p> <p>5.7 Leak Toxicity: None</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.</p>				

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 0 °F (-17.8 °C)</p> <p>6.2 Flammable Limits in Air: 1.4 - 7.4 %</p> <p>6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide</p> <p>6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective</p> <p>6.5 Special Hazards of Combustion Products: None</p> <p>6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back</p> <p>6.7 Ignition Temperature: Data not available</p> <p>6.8 Electrical Hazard: Class I, group D</p> <p>6.9 Burning Rate: 4 mm/min</p>		<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 91 ppm, 24 hr, juvenile American shad, 11 µg, fresh water; 91 ppm, 24 hr, juvenile American shad, 11 µg, salt water</p> <p>8.2 Waterfowl Toxicity: Data not available</p> <p>8.3 Biological Oxygen Demand (BOD): 8% - 8 days</p> <p>8.4 Food Chain Concentration Potential: None</p>																																					
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity with Water: No reaction</p> <p>7.2 Reactivity with Common Materials: No reaction</p> <p>7.3 Stability During Transport: Stable</p> <p>7.4 Neutralizing Agents for Acids and Caustics: Not pertinent</p> <p>7.5 Polymerization: Not pertinent</p> <p>7.6 Inhibitor of Polymerization: Not pertinent</p>		<p>9. SELECTED MANUFACTURERS</p> <p>1. Exxon Co., 30 Rockefeller Plaza, New York, N.Y. 10020</p> <p>2. Shell Oil Co., 1 Shell Plaza, Houston, Texas 77001</p> <p>3. Sun Oil Co., St. Davids, Pa. 19087</p>																																					
<p>11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-T-U-V-W</p>		<p>10. SHIPPING INFORMATION</p> <p>10.1 Grades or Purity: Composition varies with range of distillation temperatures used. Contains mostly isobutene, neopentane</p> <p>10.2 Storage Temperature: Ambient</p> <p>10.3 Inert Atmosphere: No requirement</p> <p>10.4 Venting: Open flame arrester or pressure vacuum</p>																																					
<p>12. HAZARD CLASSIFICATIONS</p> <p>12.1 Code of Federal Regulations: Flammable liquid</p> <p>12.2 NAB Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>1</td> </tr> <tr> <td>Health</td> <td>1</td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td>1</td> </tr> <tr> <td>Human Toxicity</td> <td>2</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>2</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td>0</td> </tr> <tr> <td>Other Chemicals</td> <td>0</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self-Reaction</td> <td>0</td> </tr> </tbody> </table> <p>12.3 NFPA Hazard Classifications:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>1</td> </tr> <tr> <td>Flammability (Red)</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>		Category	Rating	Fire	1	Health	1	Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution	1	Human Toxicity	2	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity	0	Other Chemicals	0	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	1	Flammability (Red)	1	Reactivity (Yellow)	0	<p>13. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>13.1 Physical State at 15°C and 1 atm: Liquid</p> <p>13.2 Molecular Weight: Not pertinent</p> <p>13.3 Boiling Point at 1 atm: 18 - 21 °C = 64 - 70 °F = 273 - 293 K</p> <p>13.4 Freezing Point: Not pertinent</p> <p>13.5 Critical Temperature: Not pertinent</p> <p>13.6 Critical Pressure: Not pertinent</p> <p>13.7 Specific Gravity: 0.70 (at 15°C, liquid)</p> <p>13.8 Liquid Surface Tension: 24.0 dyne/cm at 15°C</p> <p>13.9 Liquid-Water Interfacial Tension: 49.0 dyne/cm at 15°C</p> <p>13.10 Vapor (Gas) Specific Gravity: 1.4</p> <p>13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent</p> <p>13.12 Latent Heat of Vaporization: 110,000 Btu/lb = 50,000 kJ/kg</p> <p>13.13 Heat of Combustion: 10,000 Btu/lb = 4,500 kJ/kg</p> <p>13.14 Heat of Decomposition: Not pertinent</p> <p>13.15 Heat of Solution: Not pertinent</p> <p>13.16 Heat of Polymerization: Not pertinent</p>	
Category	Rating																																						
Fire	1																																						
Health	1																																						
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<p>5. HEALTH HAZARDS (Cont'd.)</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin</p> <p>5.10 Odor Threshold: 0.25 ppm</p>																																							

GASOLINES: STRAIGHT RUN

Common Synonyms		Watery liquid	Colorless	Gasoline odor
		Floats on water. Flammable, irritating vapor is produced.		
		FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area.		
Exposure	VAPOR. Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headache, difficult breathing or loss of consciousness.			
	LIQUID. Irritating to skin and eyes. If swallowed, will cause nausea or vomiting.			
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes.			
1. RESPONSE TO DISCHARGE <small>See Response Methods Handbook, CG 446-4.</small> Issue warning - high flammability. Evacuate area. Disperse and flush.		2. LABEL 		
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: No common synonyms. 3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures. 3.3 Chemical Formula: Not pertinent. 3.4 IMCO/United Nations Numerical Designation: 1.1, 1.2, 1.3.		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid. 4.2 Color: Colorless. 4.3 Odor: Gasoline.		
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Protective goggles, gloves. 5.2 Symptoms Following Exposure: INHALATION causes irritation of upper respiratory tract, central nervous system stimulation followed by depression of varying degrees ranging from dizziness, headache, and incoordination to anesthesia, coma, and respiratory arrest, irregular heartbeat is dangerous complication. ASPIRATION causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema. Later, signs of bronchopneumonia and pneumonitis, acute onset of central nervous system excitement followed by depression. INGESTION causes irritation of mucous membranes of throat, esophagus, and stomach, stimulation followed by depression of central nervous system, irregular heartbeat. 5.3 Treatment for Exposure: Seek medical attention. INHALATION: maintain respiration, give oxygen if needed. ASPIRATION: enforce bed rest, administer oxygen. INGESTION: do NOT induce vomiting, lavage carefully if appreciable quantity was ingested, guard against aspiration into lungs. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): No single TLV applicable. 5.5 Short-Term Inhalation Limits: 500 ppm for 10 min. 5.6 Toxicity by Ingestion: Grade 2, LD ₅₀ 0.5 to 5 g/kg. 5.7 Late Toxicity: None.				

6. FIRE HAZARDS

6.1 **Flash Point:**
(a) $< 0^{\circ}\text{F}$ ($< 0^{\circ}\text{C}$)
(b) 0°F (0°C)

6.2 **Flammable Limits in Air:**
(a) 1.1% - 7.1%

6.3 **Fire Extinguishing Agents:** Dry chemical, foam, carbon dioxide

6.4 **Fire Extinguishing Agents Not to be Used:**
Water may be ineffective

6.5 **Special Hazards of Combustion Products:**
None

6.6 **Behavior in Fire:** Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back

6.7 **Ignition Temperature:**
Data not available

6.8 **Electrical Hazard:** Class I, group D

6.9 **Burning Rate:** 4 mm/min

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:**
No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Not pertinent

7.6 **Inhibitor of Polymerization:**
Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
90 ppm - 24 hr. juvenile American shad
11 mg/l fresh water
91 ppm - 24 hr. juvenile American shad
11 mg/l salt water

8.2 **Waterfowl Toxicity:**
Data not available

8.3 **Biological Oxygen Demand (BOD):**
8% 5 days

8.4 **Food Chain Concentration Potential:**
None

9. SELECTED MANUFACTURERS

1. Exxon Co.
30 Rockefeller Plaza
New York, N.Y. 10020

2. Shell Oil Co.
1 Shell Plaza
Houston, Texas 77001

3. Sun Oil Co.
St. Davids, Pa. 19087

10. SHIPPING INFORMATION

10.1 **Grades or Purity:** Composition varies with range of distillation temperatures used

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Open flame arresters or pressure vacuum

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)

A-T-C-A-W

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:**
Flammable liquid

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	1
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	1
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	0
Other Chemicals	0
Water	0
Self Reaction	0

12.3 **NFPA Hazard Classifications:**

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid

13.2 **Molecular Weight:** Not pertinent

13.3 **Boiling Point at 1 atm:** 55 - 275°C = 14 - 135°C = 287 - 408 K

13.4 **Freezing Point:** Not pertinent

13.5 **Critical Temperature:** Not pertinent

13.6 **Critical Pressure:** Not pertinent

13.7 **Specific Gravity:** 0.71 - 0.747 at 15°C (liquid)

13.8 **Liquid Surface Tension:** 19 - 23 dynes/cm = 0.019 - 0.023 N/m at 20°C

13.9 **Liquid-Water Interfacial Tension:** 49 - 51 dynes/cm = 0.049 - 0.051 N/m at 30°C

13.10 **Vapor (Gas) Specific Gravity:** 3.4

13.11 **Ratio of Specific Heats of Vapor (Gas):**
Not pertinent

13.12 **Latent Heat of Vaporization:** 130 - 150 Btu/lb = 71 - 81 cal/g = 3.0 - 3.4 $\times 10^5$ J/kg

13.13 **Heat of Combustion:** -18,720 Btu/lb = -70,400 cal/g = -435.4 $\times 10^3$ J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

(Continued on pages 4 and 6)

5. HEALTH HAZARDS (Cont'd.)

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary

5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin

5.10 **Odor Threshold:** 0.25 ppm

HYDRAZINE

Common Synonyms	Watery liquid	Colorless	Ammonia odor
Mixes with water. Poisonous. Flammable vapor is produced. Freezing point is 35° F.			
AVOID CONTACT WITH LIQUID AND VAPOR. Keep people away. Wear chemical protective suit with self-contained breathing apparatus. Stop discharge if possible. Call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.			
<div>Fire</div>	<div>FLAMMABLE</div> <div>Flashback along vapor trail may occur.</div> <div>Vapor may explode if ignited in an enclosed area.</div> <div>Wear chemical protective suit with self-contained breathing apparatus.</div> <div>Combat fires from safe distance or protected location.</div> <div>Flood discharge area with water.</div> <div>Extinguish with dry chemical, alcohol foam, or carbon dioxide.</div> <div>Cool exposed containers with water.</div> <div>Continue cooling after fire has been extinguished.</div>		
<div><div>Skull and crossbones</div><div>Exposure</div></div>	<div>CALL FOR MEDICAL AID.</div> <div>VAPOR POISONOUS IF INHALED OR IF SKIN IS EXPOSED.</div> <div>Irritating to eyes.</div> <div>Move to fresh air.</div> <div>If breathing has stopped, give artificial respiration.</div> <div>If breathing is difficult, give oxygen.</div> <div>LIQUID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.</div> <div>Will burn eyes.</div> <div>Remove contaminated clothing and shoes.</div> <div>Flush affected areas with plenty of water.</div> <div>IF IN EYES, hold eyelids open and flush with plenty of water.</div> <div>IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</div> <div>DO NOT INDUCE VOMITING.</div>		
<div>Water Pollution</div>	<div>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.</div> <div>May be dangerous if it enters water intakes.</div> <div>Notify local health and wildlife officials.</div> <div>Notify operators of nearby water intakes.</div>		
<div>1. RESPONSE TO DISCHARGE</div> <div>(See Response Methods Handbook CG 446-4)</div> <div>Issue warning - high flammability, corrosive.</div> <div>Restrict access.</div> <div>Chemical and physical treatment.</div>		<div>2. LABELS</div> <div><div><div></div></div><div><div>POISON</div></div></div>	
<div>3. CHEMICAL DESIGNATIONS</div> <div>3.1 Synonyms: No common synonyms.</div> <div>3.2 Coast Guard Compatibility Classification: Not applicable.</div> <div>3.3 Chemical Formula: N₂H₄.</div> <div>3.4 IMCO United Nations Numerical Designation: 8.0 2030.</div>		<div>4. OBSERVABLE CHARACTERISTICS</div> <div>4.1 Physical State (as shipped): Liquid.</div> <div>4.2 Color: Colorless.</div> <div>4.3 Odor: Ammonia-like.</div>	
<div>5. HEALTH HAZARDS</div> <div>5.1 Personal Protective Equipment: Ammonia-type gas mask, self-contained breathing apparatus, plastic coated or rubber gloves, clothes, and apron, safety shower must be available.</div> <div>5.2 Symptoms Following Exposure: Vapors cause itching, swelling, and blistering of eyelids, skin, nose and throat; symptoms may be delayed for several hours. Temporary blindness may occur. Liquid causes a caustic-like burn if not washed off at once. Ingestion or absorption through skin causes nausea, dizziness, headache. Severe exposure may cause death.</div> <div>5.3 Treatment for Exposure: Call a doctor at once. INHALATION: remove to fresh air, observe for development of delayed symptoms. Keep quiet. INGESTION: do NOT induce vomiting, give egg whites or other emollient. SKIN OR EYES: wash with large amounts of water for at least 15 min.</div> <div>5.4 Toxicity by Inhalation (Threshold Limit Value): 1 ppm.</div> <div>5.5 Short-Term Inhalation Limits: 1 ppm for 30 min.</div> <div>5.6 Toxicity by Ingestion: Grade 3, LD₅₀ 50 to 500 mg/kg (rat).</div> <div>5.7 Late Toxicity: Causes lung cancer in mice.</div> <div>5.8 Vapor (Gas) Irritant Characteristics: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.</div> <div>5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact, very injurious to the eyes.</div> <div>5.10 Odor Threshold: 3 - 4 ppm.</div>			

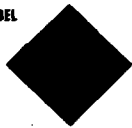
<div>6. FIRE HAZARDS</div> <div>6.1 Flash Point: 100°F (3°C)</div> <div>6.2 Flammable Limits in Air: 4.7% - 100%</div> <div>6.3 Fire Extinguishing Agents: Water, alcohol foam, carbon dioxide, or dry chemical</div> <div>6.4 Fire Extinguishing Agents Not to be Used: Not pertinent</div> <div>6.5 Special Hazards of Combustion Products: Toxic vapor is generated when heated</div> <div>6.6 Behavior in Fire: May explode if confined</div> <div>6.7 Ignition Temperature: 410°C (770°F) (approx.)</div> <div>6.8 Electrical Hazard: Not pertinent</div> <div>6.9 Burning Rate: 1.0 in/min (2.5 cm/min)</div>	<div>8. WATER POLLUTION</div> <div>8.1 Aquatic Toxicity: 146 ppm/24 hr rainbow trout, died, fresh water</div> <div>8.2 Waterfowl Toxicity: Data not available</div> <div>8.3 Biological Oxygen Demand (BOD): 100%</div> <div>8.4 Food Chain Concentration Potential: None</div>																																				
<div>7. CHEMICAL REACTIVITY</div> <div>7.1 Reactivity with Water: No reaction</div> <div>7.2 Reactivity with Common Materials: Can catch fire when in contact with porous materials such as wood, asbestos, cloth, earth and rusty metals</div> <div>7.3 Stability During Transport: Stable at ordinary temperatures. When heated, can decompose to nitrogen and ammonia gases, but decomposition is not hazardous unless material is confined</div> <div>7.4 Neutralizing Agents for Acids and Caustics: Flush with water. Neutralize the resulting solution with calcium hypochlorite (HTH) (1 lb per lb of hydrazine)</div> <div>7.5 Polymerization: Not pertinent</div> <div>7.6 Inhibitor of Polymerization: Not pertinent</div>	<div>9. SELECTED MANUFACTURERS</div> <div>1. Farmount Chemical Co., Inc. 117 Blanchard St. Newark, N.J. 07105</div> <div>2. Olin Corp. Chemicals Division 1201 Long Ridge Rd. Stamford, Conn. 06904</div> <div>3. Unimul, Inc. Unimul Chemical Division Spencer St. Naugatuck, Conn. 06770</div>																																				
<div>11. HAZARD ASSESSMENT CODE</div> <div>(See Hazard Assessment Handbook CG 446-3)</div> <div>A-P-Q</div>	<div>10. SHIPPING INFORMATION</div> <div>10.1 Grades or Purity: Anhydrous, 15 - 64% water solutions</div> <div>10.2 Storage Temperature: Ambient</div> <div>10.3 Inert Atmosphere: Padded</div> <div>10.4 Venting: Pressure-vacuum</div>																																				
<div>12. HAZARD CLASSIFICATIONS</div> <div>12.1 Code of Federal Regulations: Flammable Liquid</div> <div>12.2 NAS Hazard Rating for Bulk Water Transportation:</div> <table><thead><tr><th>Category</th><th>Rating</th></tr></thead><tbody><tr><td>Fire</td><td>4</td></tr><tr><td>Health</td><td></td></tr><tr><td>Vapor Irritant</td><td>3</td></tr><tr><td>Liquid or Solid Irritant</td><td>4</td></tr><tr><td>Poisons</td><td>4</td></tr><tr><td>Water Pollution</td><td></td></tr><tr><td>Human Toxicity</td><td>4</td></tr><tr><td>Aquatic Toxicity</td><td>3</td></tr><tr><td>Aesthetic Effect</td><td>2</td></tr><tr><td>Reactivity</td><td></td></tr><tr><td>Other Chemicals</td><td>4</td></tr><tr><td>Water</td><td>0</td></tr><tr><td>Self-Reaction</td><td>4</td></tr></tbody></table> <div>12.3 NFPA Hazard Classifications:</div> <table><thead><tr><th>Category</th><th>Classification</th></tr></thead><tbody><tr><td>Health Hazard (Blue)</td><td>3</td></tr><tr><td>Flammability (Red)</td><td>3</td></tr><tr><td>Reactivity (Yellow)</td><td>2</td></tr></tbody></table>	Category	Rating	Fire	4	Health		Vapor Irritant	3	Liquid or Solid Irritant	4	Poisons	4	Water Pollution		Human Toxicity	4	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	4	Water	0	Self-Reaction	4	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	3	Reactivity (Yellow)	2	<div>13. PHYSICAL AND CHEMICAL PROPERTIES</div> <div>13.1 Physical State at 15°C and 1 atm: Liquid</div> <div>13.2 Molecular Weight: 32.05</div> <div>13.3 Boiling Point at 1 atm: 236.3°F = 113.5°C = 386.7°K</div> <div>13.4 Freezing Point: 34.7°F = 1°C = 273°K</div> <div>13.5 Critical Temperature: 718°F = 380°C = 653°K</div> <div>13.6 Critical Pressure: 2130 psia = 145 atm = 14.7 MN/m²</div> <div>13.7 Specific Gravity: 1.008 at 20°C (liquid)</div> <div>13.8 Liquid Surface Tension: Not pertinent</div> <div>13.9 Liquid-Water Interfacial Tension: Not pertinent</div> <div>13.10 Vapor (Gas) Specific Gravity: Not pertinent</div> <div>13.11 Ratio of Specific Heats of Vapor (Gas): 1.191</div> <div>13.12 Latent Heat of Vaporization: 515 Btu/lb = 599 cal/g = 12.5 x 10³ J/kg</div> <div>13.13 Heat of Combustion: -5345 Btu/lb = -4636 cal/g = -194 x 10³ J/kg</div> <div>13.14 Heat of Decomposition: Not pertinent</div> <div>13.15 Heat of Solution: -218 Btu/lb = -121 cal/g = -5.07 x 10³ J/kg</div> <div>13.16 Heat of Polymerization: Not pertinent</div>
Category	Rating																																				
Fire	4																																				
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<div>Continued on pages 1 and 6</div>																																					
<div>NOTES</div>																																					

HDQ

HYDROQUINONE



Common Synonyms 1,4-Benzenediol p-Dihydroxybenzene Hydroquinol Pyroquinetic acid Quinol	Solid White, light tan to gray Sinks and mixes with water.
Avoid contact with solid and dust. Keep people away. Shut off ignition sources. Call fire department. Stop discharging, if possible. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Combustible Dust cloud may explode if ignited in an enclosed area. Extinguish with water, dry chemicals, foam, or carbon dioxide.
Exposure	CALL FOR MEDICAL AID. DUST Irritating to eyes, nose and throat. Harmful if inhaled. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. SOLID Will burn eyes. Irritating to eyes. If swallowed will cause headache, dizziness, nausea, vomiting, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446-4)</small> Issue warning water contaminant Disperse and flush	
2. LABELS No hazard label required by Code of Federal Regulations	
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: 1,4-Benzenediol, p-Dihydroxybenzene, Hydroquinol, Pyroquinetic acid, Quinol 3.2 Coast Guard Compatibility Classification: Not listed 3.3 Chemical Formula: 1,4-C ₆ H ₄ (OH) ₂ 3.4 IMCO/United Nations Numerical Designation: Not listed	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Solid 4.2 Color: Light tan to light gray; white 4.3 Odor: None
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Goggles, respiratory protection if dust is present 5.2 Symptoms Following Exposure: Ingestion can cause ringing in the ears, nausea, dizziness, a sense of suffocation, increased respiration rate, vomiting, pallor, muscular twitchings, headache, dyspnea, cyanosis, delirium, and collapse; the urine is green or brownish-green. Lethal adult dose is 2 grams. Direct contamination of the eye with particles of hydroquinone can cause immediate irritation and may result in ulceration of the cornea. Contact with skin may cause dermatitis. 5.3 Treatment for Exposure: INGESTION: induce vomiting; perform gastric lavage, and follow with a saline cathartic and demulcents; get medical attention. EYES: flush immediately with plenty of water for 15 min. and get medical attention. SKIN: wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): 2 mg/m ³ 5.5 Short-Term Inhalation Limits: Data not available 5.6 Toxicity by Ingestion: Grade 3, LD ₅₀ 370 mg/kg (rat) 5.7 Late Toxicity: Causes bladder cancer in mice, discoloration of eyelids and eye changes in men 5.8 Vapor (Gas) Irritant Characteristics: Data not available 5.9 Liquid or Solid Irritant Characteristics: Data not available 5.10 Odor Threshold: Data not available	

6. FIRE HAZARDS 6.1 Flash Point: (molten) 350°F O C 6.2 Flammable Limits in Air: Not pertinent 6.3 Fire Extinguishing Agents: Water, foam, dry chemical, carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: 6.5 Special Hazards of Combustion Products: 6.6 Behavior in Fire: Dust explosion is possible 6.7 Ignition Temperature: Data not available 6.8 Electrical Hazard: Data not available 6.9 Burning Rate: Not pertinent	8. WATER POLLUTION 8.1 Aquatic Toxicity: 0.287 ppm/48 hr/goldfish/TI ₉₆ /fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 53%, 5 days 25% (theo.), 0.5 days, as catechol 8.4 Food Chain Concentration Potential: None
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS 1 Eastman Chemical Products, Inc. Kingsport, Tenn. 37662 2 Allied Chemical Corp. Specialty Chemicals Div. P.O. Box 1087R Morristown, N.J. 07960 3 Aldrich Chemical Co. 940 W. Saint Paul Ave. Milwaukee, Wis. 53233
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 446-3)</small> SS	10. SHIPPING INFORMATION 10.1 Grades or Purities: Pure, Technical 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Not listed 12.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 12.3 MFPA Hazard Classifications: Not listed	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Solid 13.2 Molecular Weight: 110.11 13.3 Boiling Point at 1 atm: 545°F = 285°C = 558°K 13.4 Freezing Point: 338°F = 170°C = 443°K 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 1.33 at 20°C (solid) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 13.12 Latent Heat of Vaporization: Not pertinent 13.13 Heat of Combustion: -11,200 Btu/lb = -6,220 cal/g = -260 × 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent
NOTES <small>(Continued on pages 5 and 6)</small>	

Common Synonyms		Watery liquid	Colorless	Fuel oil odor																																				
		Floats on water																																						
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Avoid contact with liquid. Isolate and remove discharged material. Notify local health and pollution control agencies.																																								
Fire		FLAMMABLE Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.																																						
Exposure		CALL FOR MEDICAL AID. LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.																																						
Water Pollution		Dangerous to aquatic life in high concentrations. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.																																						
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning - high flammability Mechanical containment Should be removed Chemical and physical treatment		2. LABEL 																																						
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: No common synonyms 3.2 Coast Guard Competibility Classification: Miscellaneous hydrocarbon mixtures 3.3 Chemical Formula: C ₁₂ H ₂₆ 3.4 IMCO/United Nations Numerical Designation: 3.2/1863		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless to light brown 4.3 Odor: Like fuel oil																																						
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Protective gloves, goggles or face shield 5.2 Symptoms Following Exposure: Vapor causes slight irritation of eyes and nose. Liquid irritates stomach, if taken into lungs, causes coughing, distress, and rapidly developing pulmonary edema 5.3 Treatment for Exposure: ASPIRATION: enforce bed rest, administer oxygen, call a doctor. INGESTION: do NOT induce vomiting, call a doctor. EYES: wash with plenty of water. SKIN: wipe off and wash with soap and water 5.4 Toxicity by Inhalation (Threshold Limit Value): 200 ppm 5.5 Short-Term Inhalation Limits: 2500 mg/m ³ for 60 min. 5.6 Toxicity by Ingestion: Grade 2 LD ₅₀ 5 to 5 g/kg 5.7 Late Toxicity: Data not available 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin 5.10 Odor Threshold: 1 ppm																																								
6. FIRE HAZARDS 6.1 Flash Point: -10°F to +30°F C C 6.2 Flammable Limits in Air: 1.1% - 8.0% 6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 464°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: 4 mm/min																																								
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent																																								
8. WATER POLLUTION 8.1 Aquatic Toxicity: 500 ppm/* salmon-imperting, lethal fresh water *Time period not specified 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 53%, 5 days 8.4 Food Chain Concentration Potential: None																																								
9. SELECTED MANUFACTURERS 1. Exxon Co. 30 Rockefeller Plaza New York, N.Y. 10020 2. Shell Oil Co. 1 Shell Plaza Houston, Tex. 77001 3. Sun Oil Co. 240 Radnor Rd. St. Davids, Pa. 19087																																								
10. SHIPPING INFORMATION 10.1 Grades or Purity: 99.9% 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open (flame arrester) or pressure/vacuum																																								
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-T-U																																								
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid 12.2 NAS Hazard Rating for Bulk Water Transportation: <table><thead><tr><th>Category</th><th>Rating</th></tr></thead><tbody><tr><td>Fire</td><td>3</td></tr><tr><td>Health</td><td>1</td></tr><tr><td>Vapor Irritant</td><td>1</td></tr><tr><td>Liquid or Solid Irritant</td><td>1</td></tr><tr><td>Poisons</td><td>1</td></tr><tr><td>Water Pollution</td><td>1</td></tr><tr><td>Human Toxicity</td><td>1</td></tr><tr><td>Aquatic Toxicity</td><td>1</td></tr><tr><td>Aesthetic Effect</td><td>3</td></tr><tr><td>Reactivity</td><td>0</td></tr><tr><td>Other Chemicals</td><td>0</td></tr><tr><td>Water</td><td>0</td></tr><tr><td>Self-Reaction</td><td>0</td></tr></tbody></table> 12.3 NFPA Hazard Classifications: <table><thead><tr><th>Category</th><th>Classification</th></tr></thead><tbody><tr><td>Health Hazard (Blue)</td><td>0</td></tr><tr><td>Flammability (Red)</td><td>2</td></tr><tr><td>Reactivity (Yellow)</td><td>0</td></tr></tbody></table>					Category	Rating	Fire	3	Health	1	Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	1	Water Pollution	1	Human Toxicity	1	Aquatic Toxicity	1	Aesthetic Effect	3	Reactivity	0	Other Chemicals	0	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	0	Flammability (Red)	2	Reactivity (Yellow)	0
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Flammability (Red)	2																																							
Reactivity (Yellow)	0																																							
13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: Not pertinent 13.3 Boiling Point at 1 atm: 349 - 349.1 = 176 - 287°C = 449 - 560 K 13.4 Freezing Point: < -34°F = < -48°C = < 225 K 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 0.81 at 20°C (liquid) 13.8 Liquid Surface Tension: (test) 25 dynes/cm = 0.025 N/m at 20°C 13.9 Liquid-Water Interfacial Tension: (test) 50 dynes/cm = 0.05 N/m at 20°C 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): (test) 1.030 13.12 Latent Heat of Vaporization: 140 Btu/lb = 78 cal/g = 3.3 X 10 ³ J/kg 13.13 Heat of Combustion: -18,540 Btu/lb = -10,300 cal/g = -43.24 X 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent																																								
(Continued on pages 5 and 6)																																								
NOTES																																								

MLT

MALATHION



Common Synonyms: Cythion Insecticide		Liquid Yellow to dark brown Skunk-like odor
		Sinks in water. Freezing point is 37° F.
AVOID CONTACT WITH LIQUID. Keep people away. Wear chemical protective suit with self-contained breathing apparatus. Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.		
Fire	Combustible: POISONOUS GASES ARE PRODUCED IN FIRE AND WHEN HEATED. Containers may explode in fire. Wear chemical protective suit with self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, water, or foam. Cool exposed containers with water.	
	CALL FOR MEDICAL AID: LIQUID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. Irritating to eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.	
Exposure		
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.	
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 448-4)</small> Issue warning: poison, water contaminant. Restrict access. Should be removed. Chemical and physical treatment.		2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: CYTHION Insecticide S-[1,2-Bis (ethoxycarbonyl) ethyl] 0,0-dimethyl phosphorodithioate 3.2 Coast Guard Compatibility Classification: Not applicable 3.3 Chemical Formula: C ₁₀ H ₁₆ O ₄ PS ₂ 3.4 HMCO/United Nations Numerical Designation: 6.1/1893		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Yellow to dark brown 4.3 Odor: Characteristic skunk-like mercaptan
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Wear self-contained breathing apparatus (or respirator for organophosphate pesticides) and rubber clothing while fighting fires of malathion with chlorine bleach solution. All clothing contaminated by fumes and vapors must be decontaminated. 5.2 Symptoms Following Exposure: Exposure to fumes from a fire or to liquid causes headache, blurred vision, constricted pupils of the eyes, weakness, nausea, cramps, diarrhea, and tightness in the chest. Muscles twitch and convulsions may follow. The symptoms may develop over a period of 8 hours. 5.3 Treatment for Exposure: Speed is essential. INHALATION: in the nonbreathing victim immediately institute artificial respiration, using the mouth-to-mouth, the mouth-to-nose, or the mouth-to-oropharyngeal method. Call physician! INGESTION: administer milk, water or salt water and induce vomiting repeatedly. SKIN OR EYE CONTACT: flood and wash exposed skin areas thoroughly with water. Remove contaminated clothing under a shower. Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted, repeat the administration of atropine every 3-8 min. until signs of atropinization (mydriasis, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 1 mg of atropine. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway, intubate if necessary. Give 2-PAM (Pralidoxime, Protopam), 2.5 gm in 100 ml of sterile water or in 5% dextrose and water, intravenously, slowly, in 15-30 min., if sufficient fluid is not available, give 1 gm of 2-PAM in 1 ml of distilled water by deep intramuscular injection, repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur.		

6. FIRE HAZARDS 6.1 Flash Point: > 325°F 6.2 Flammable Limits in Air: Data not available 6.3 Fire Extinguishing Agents: Dry chemical, carbon dioxide, water spray, foam 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Vapors and fumes from fires are hazardous. They include sulfur dioxide and phosphoric acid. 6.6 Behavior in Fire: Gives off hazardous fumes. Area surrounding fire should be diked to prevent water runoff. 6.7 Ignition Temperature: Data not available 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Data not available		8. WATER POLLUTION 8.1 Aquatic Toxicity: 0.09 ppm/96 hr/bluegill/TL _m /fresh water 0.033-0.063 ppm/96 hr/marine crustaceae/LC ₅₀ 8.2 Waterfowl Toxicity: LD ₅₀ =1485 mg/kg 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: None 7.2 Reactivity with Common Materials: No hazardous reaction 7.3 Stability During Transport: Not pertinent 7.4 Neutralizing Agents for Acids and Caustics: Liquid bleach solution for decontamination. 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent		9. SELECTED MANUFACTURERS American Cyanamid Co. Agricultural Division P. O. Box 400 Princeton, N. J. 08540
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 448-3)</small> A-X-Y		10. SHIPPING INFORMATION 10.1 Grade or Purity: CYTHION Insecticide, Malathion U/LV Concentrate Insecticide. Many powders, dusts, and spray solutions are sold under a variety of trade names. 10.2 Storage Temperature: Below 120°F. Decomposition (non-hazardous) occurs at higher temperatures. 10.3 Inert Atmosphere: Data not available 10.4 Venting: Data not available
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Poisonous liquid or solid, Class B 12.2 NAH Hazard Rating for Bulk Water Transportation: Not listed 12.3 NFPA Hazard Classifications: Not listed		13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 330.36 13.3 Boiling Point at 1 atm: Very high 13.4 Freezing Point: 37°F = 2.9°C = 276°K 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 1.234 at 25°C (liquid) 13.8 Liquid Surface Tension: 37.1 dynes/cm = 0.0371 N/m at 24°C 13.9 Liquid-Water Interfacial Tension: 19 dynes/cm = 0.019 N/m at 24°C 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 13.12 Latent Heat of Vaporization: Not pertinent 13.13 Heat of Combustion: Data not available 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent
5. HEALTH HAZARDS (Cont'd.) 5.4 Toxicity by Inhalation (Threshold Limit Value): 10 mg/m ³ 5.5 Short-Term Inhalation Limits: Data not available 5.6 Toxicity by Ingestion: Grade 2, LD ₅₀ 0.5 to 5 g/kg (rat) 5.7 Late Toxicity: Data not available 5.8 Vapor (Gas) Irritant Characteristics: None likely 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: Data not available		


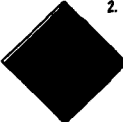

(Continued on pages 5 and 6.)

MAL

METHYL ALCOHOL

Common Synonyms Methyl alcohol Wood alcohol Wood naphtha Wood spirit Pyrolytic spirit	
Watery liquid	Colorless Alcohol odor
Flonks and mixes with water. Flammable, irritating vapor is produced.	
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	FLAMMABLE. Vapor may explode if ignited in an enclosed area. Flashback along vapor trail may occur. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID POISONOUS IF SWALLOWED. Irritating to skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYE: hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.
Exposure	
Water Pollution	Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning: high flammability Restrict access Evacuate area Disperse and flush	2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Colonial spirit Wood alcohol Columbian spirit Wood naphtha Methanol Wood spirit 3.2 Coast Guard Compatibility Classification: Alcohol 3.3 Chemical Formula: CH ₃ OH 3.4 IMCO/United Nations Numerical Designation: 3.2/1230	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Faint alcohol; like ethyl alcohol; faintly sweet, characteristic pungent
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Approved canister mask for high vapor concentrations; safety goggles; rubber gloves 5.2 Symptoms Following Exposure: Exposure to excessive vapor causes eye irritation, headache, fatigue and drowsiness. High concentrations can produce central nervous system depression and optic nerve damage. 50,000 ppm will probably cause death in 1 to 2 hrs. Can be absorbed through skin. Swallowing may cause death or eye damage. 5.3 Treatment for Exposure: Remove victim from exposure and apply artificial respiration if breathing has ceased. INGESTION: induce vomiting, then give 2 teaspoons of baking soda in glass of water; call a physician. SKIN OR EYES: flush with water for 15 min. 5.4 Toxicity by Inhalation (Threshold Limit Value): 200 ppm 5.5 Short-Term Inhalation Limit: 260 mg/m ³ for 60 min. 5.6 Toxicity by Ingestion: Grade 1; 5 to 15 g/kg (rat) 5.7 Lethal Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 100 ppm	

6. FIRE HAZARDS 5.1 Flash Point: 54°F C.C., 61°F O.C. 5.2 Flammable Limits in Air: 6.0% - 36.5% 5.3 Fire Extinguishing Agents: Alcohol foam, dry chemical, or carbon dioxide 5.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 5.5 Special Hazards of Combustion Products: Not pertinent 5.6 Behavior in Fire: Containers may explode. 5.7 Ignition Temperature: 867°F 5.8 Electrical Hazard: Class I, Group D 5.9 Burning Rate: 1.7 mm/min.	8. WATER POLLUTION 8.1 Aquatic Toxicity: 250 ppm/11 hr, goldfish died; fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 0.6 to 1.12 lb/lb in 5 days 8.4 Food Chain Concentration Potential: None																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS 1 Borden Inc. Borden Chemical Division Geismar, La. 70734 2 Celanese Corp. Celanese Chemical Co. Division 245 Park Ave. New York, N. Y. 10017 3 E. I. du Pont de Nemours & Co., Inc. Industrial and Biochemical Dept. Wilmington, Del. 19898																																				
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-P-Q-R-S	10. SHIPPING INFORMATION 10.1 Grades or Purities: C.P. Crude, ACS all 99.9% 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open (flame arrester) or pressure-vacuum																																				
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid 12.2 NAS Hazard Rating for Bulk Water Transportation: <table><thead><tr><th>Category</th><th>Rating</th></tr></thead><tbody><tr><td>Fire</td><td>3</td></tr><tr><td>Health</td><td></td></tr><tr><td>Vapor Irritant</td><td>1</td></tr><tr><td>Liquid or Solid Irritant</td><td>1</td></tr><tr><td>Poisons</td><td>2</td></tr><tr><td>Water Pollution</td><td></td></tr><tr><td>Human Toxicity</td><td>1</td></tr><tr><td>Aquatic Toxicity</td><td>1</td></tr><tr><td>Aesthetic Effect</td><td>1</td></tr><tr><td>Reactivity</td><td></td></tr><tr><td>Other Chemicals</td><td>2</td></tr><tr><td>Water</td><td>0</td></tr><tr><td>Self-Reaction</td><td>0</td></tr></tbody></table> 12.3 NFPA Hazard Classifications: <table><thead><tr><th>Category</th><th>Classification</th></tr></thead><tbody><tr><td>Health Hazard (Blue)</td><td>1</td></tr><tr><td>Flammability (Red)</td><td>3</td></tr><tr><td>Reactivity (Yellow)</td><td>0</td></tr></tbody></table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	1	Aesthetic Effect	1	Reactivity		Other Chemicals	2	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	1	Flammability (Red)	3	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 32.04 13.3 Boiling Point at 1 atm: 148.1°F = 64.5°C = 337.7°K 13.4 Freezing Point: -144.0°F = -97.8°C = 175.4°K 13.5 Critical Temperature: 464°F = 240°C = 513°K 13.6 Critical Pressure: 1142.0 psia = 77.7 atm = 7.87 MN/m ² 13.7 Specific Gravity: 0.792 at 20°C (liquid) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: 1.1 13.11 Ratio of Specific Heats of Vapor (Gas): 1.254 13.12 Latent Heat of Vaporization: 473.0 Btu/lb = 262.8 cal/g = 11.00 X 10 ³ J/kg 13.13 Heat of Combustion: -8419 Btu/lb = -4677 cal/g = -195.8 X 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: (ext.) -9 Btu/lb = -5 cal/g = -0.2 X 10 ³ J/kg 13.16 Heat of Polymerization: Not pertinent
Category	Rating																																				
Fire	3																																				
Health																																					
Vapor Irritant	1																																				
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NOTES (Continued on pages 5 and 6)																																					

Common Synonyms Monomethylhydrazine MMH	Liquid Colorless Ammonia-like odor Mixes with water. Poisonous, flammable vapor is produced.
AVOID CONTACT WITH LIQUID AND VAPOR. KEEP PEOPLE AWAY. Wear goggles and self-contained breathing apparatus. Shut off ignition sources. Call fire department. Stop discharge if possible. Stay upwind. Use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	FLAMMABLE. Containers may explode in fire. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. May explode if exposed to heat or flames. Extinguish with dry chemicals, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
 Exposure	Call for medical aid. VAPOR POISONOUS IF INHALED OR IF SKIN IS EXPOSED. Irritating to eyes, nose and throat. Move victim to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. Will burn skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446-4)</small> Issue warning: poison, high flammability, water contaminant, air contaminant. Restrict access. Evacuate area. Disperse and flush.	2. LABELS  
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Monomethylhydrazine; MMH 3.2 Coast Guard Compatibility Classification: Not applicable 3.3 Chemical Formula: CH ₃ NHNH ₂ 3.4 IMCO/United Nations Numerical Designation: 12/1244	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Like ammonia
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Organic canister mask or self-contained breathing apparatus; goggles or face shield; rubber gloves; protective clothing. 5.2 Symptoms Following Exposure: Tremors and convulsions follow absorption by any route. Inhalation causes focal irritation of respiratory tract, respiratory distress, and systemic effects. Contact of liquid with eyes or skin causes irritation and burns. Ingestion causes irritation of mouth and stomach. 5.3 Treatment for Exposure: Get medical attention at once following all exposures to this compound. INHALATION: move victim to fresh air and keep him quiet; give artificial respiration if breathing stops. EYES: flush for at least 15 min. with large quantities of water. SKIN: immediately wash with large quantities of water and treat as for alkali burn. INGESTION: give egg whites or other emollient, followed by a 5% salt solution or other mild emetic. Keep patient as quiet as possible. To control convulsions, short-acting barbiturates may be administered parenterally by a physician with due regard for depression of respiration. 5.4 Toxicity by Inhalation (Threshold Limit Value): 0.2 ppm 5.5 Short-Term Inhalation Limits: 90 ppm for 10 min.; 30 ppm for 30 min.; 15 ppm for 60 min. 5.6 Toxicity by Ingestion: Grade 4; oral LD ₅₀ = 33 mg/kg (rat) 5.7 Late Toxicity: Hemolytic anemia may result from large doses by any route. 5.8 Vapor (Gas) Irritant Characteristics: Vapors are moderately irritating such that personnel will not usually tolerate moderate or high concentrations.	

(Continued on page 4)

6. FIRE HAZARDS 6.1 Flash Point: 62°F O.C. 6.2 Flammable Limits in Air: 2.5% - 98% 6.3 Fire Extinguishing Agents: Water or dry chemical 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Irritating nitrogen oxides are produced. 6.6 Behavior in Fire: May explode. 6.7 Ignition Temperature: 382°F 6.8 Electrical Hazard: Data not available 6.9 Burning Rate: 2.0 mm/min	8. WATER POLLUTION 8.1 Aquatic Toxicity: Data not available 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: Reacts slowly with air, but heat may cause ignition of rags, rust, or other combustibles. 7.3 Stability During Transport: Stable if not in contact with iron, copper, or their alloys. 7.4 Neutralizing Agents for Acids and Caustics: Flush with water. 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS 1. Olin Corporation 1201 Long Ridge Road Stamford, Conn. 06904 2. Eastman Kodak Co. Eastman Organic Chemicals Rochester, N. Y. 14650 3. Aldrich Chemical Co. 940 West St. Paul Ave. Milwaukee, Wis. 53233																																				
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 446-3)</small> A-P-Q-R-S	10. SHIPPING INFORMATION 10.1 Grade or Purity: Propellant grade, 99+%; Laboratory grade, 98+%; 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: Padded with nitrogen 10.4 Venting: Safety relief																																				
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid 12.2 NAB Hazard Rating for Bulk Water Transportation: <table data-bbox="959 1370 1202 1710"> <thead> <tr> <th>Category</th><th>Rating</th></tr> </thead> <tbody> <tr> <td>Fire</td><td>4</td></tr> <tr> <td>Health</td><td>3</td></tr> <tr> <td>Vapor Irritant</td><td>3</td></tr> <tr> <td>Liquid or Solid Irritant</td><td>4</td></tr> <tr> <td>Poisons</td><td>4</td></tr> <tr> <td>Water Pollution</td><td>4</td></tr> <tr> <td>Human Toxicity</td><td>4</td></tr> <tr> <td>Aquatic Toxicity</td><td>2</td></tr> <tr> <td>Aesthetic Effect</td><td>2</td></tr> <tr> <td>Reactivity</td><td>4</td></tr> <tr> <td>Other Chemicals</td><td>4</td></tr> <tr> <td>Water</td><td>0</td></tr> <tr> <td>Self-Reaction</td><td>4</td></tr> </tbody> </table> 12.3 NFPA Hazard Classifications: <table data-bbox="959 1625 1202 1710"> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td><td>3</td></tr> <tr> <td>Flammability (Red)</td><td>3</td></tr> <tr> <td>Reactivity (Yellow)</td><td>1</td></tr> </tbody> </table>	Category	Rating	Fire	4	Health	3	Vapor Irritant	3	Liquid or Solid Irritant	4	Poisons	4	Water Pollution	4	Human Toxicity	4	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity	4	Other Chemicals	4	Water	0	Self-Reaction	4	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	3	Reactivity (Yellow)	1	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: 46.1 13.3 Boiling Point at 1 atm: 189.5°F = 87.5°C = 360.7°K 13.4 Freezing Point: -62.3°F = -52.4°C = 220.8°K 13.5 Critical Temperature: 594°F = 312°C = 585°K 13.6 Critical Pressure: 1,195 psia = 81.3 atm = 8.25 MN/m ² 13.7 Specific Gravity: 0.878 at 20°C (liquid) 13.8 Liquid Surface Tension: 34.3 dynes/cm = 0.0343 N/m at 20°C 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: 1.59 13.11 Ratio of Specific Heats of Vapor (Gas): 1.1326 13.12 Latent Heat of Vaporization: 376 Btu/lb = 209 cal/g = 8.75 × 10 ³ J/kg 13.13 Heat of Combustion: -12,178 Btu/lb = -6,766 cal/g = -283.1 × 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent
Category	Rating																																				
Fire	4																																				
Health	3																																				
Vapor Irritant	3																																				
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Health Hazard (Blue)	3																																				
Flammability (Red)	3																																				
Reactivity (Yellow)	1																																				
5. HEALTH HAZARDS (Cont'd.) 5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact and is very injurious to the eyes. 5.10 Odor Threshold: 1-3 ppm																																					

(Continued on pages 4 and 5)

Common Synonyms Petroleum solvent Drycleaner naphtha Spotting naphtha	Watery liquid Colorless Gasoline-like odor Floats on water
Stop discharge if possible. Keep people away. Call fire department. Avoid contact with liquid. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Combustible Extinguish with foam, dry chemical or carbon dioxide. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446-4)</small> Mechanical containment. Should be removed. Chemical and physical treatment.	2. LABELS No hazard label is required by Code of Federal Regulations.
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Drycleaners' naphtha Petroleum solvent Spotting naphtha 3.2 Coast Guard Competibility Classification: Miscellaneous hydrocarbon mixtures 3.3 Chemical Formula: Not applicable 3.4 IMCO/United Nations Numerical Designation: 1.1, 1.2/68	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Like gasoline
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Goggles or face shield (as for gasoline). 5.2 Symptoms Following Exposure: High concentration of vapors may cause intoxication. If liquid is swallowed, it may get into lungs by aspiration, not very irritating to skin or eyes. 5.3 Treatment for Exposure: INHALATION: remove patient from exposure, treat symptoms. INGESTION: do NOT induce vomiting! Call a doctor. EYES: flush with water for 15 min. SKIN: wipe off and wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): 200 ppm 5.5 Short-Term Inhalation Limits: 500 ppm for 30 min 5.6 Toxicity by Ingestion: Grade 2, LD ₅₀ 5 to 5 g/kg 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: Data not available.	

6. FIRE HAZARDS 6.1 Flash Point: 110°F (43°C) 6.2 Flammable Limits in Air: 0.8% - 5.0% 6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 540°F (282°C) 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 4 mm/min	8. WATER POLLUTION 8.1 Aquatic Toxicity: Data not available 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None								
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS 1. Pennsylvania Refining Co. Butler, Pa. 16001 2. Sun Oil Co. St. Davids, Pa. 19087 3. Union Oil Co. Amoco Division 1100 S. Meacham Rd. Palatine, Ill. 60067								
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 446-3)</small> A-T-U	10. SHIPPING INFORMATION 10.1 Grades or Purity: Data not available 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open (flame arrester)								
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Combustible Liquid 12.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 12.3 NFPA Hazard Classifications: <table data-bbox="915 1415 1153 1478"> <tr> <th>Category</th><th>Classification</th></tr> <tr> <td>Health Hazard (Blue)</td><td>0</td></tr> <tr> <td>Flammability (Red)</td><td>2</td></tr> <tr> <td>Reactivity (Yellow)</td><td>0</td></tr> </table>	Category	Classification	Health Hazard (Blue)	0	Flammability (Red)	2	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: Not pertinent 13.3 Boiling Point at 1 atm: 320-390°F = 160-199°C = 433-472°K 13.4 Freezing Point: Not pertinent 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 0.78 at 20°C (liquid) 13.8 Liquid Surface Tension: 19-23 dynes/cm = 0.019-0.023 N/m at 20°C 13.9 Liquid-Water Interfacial Tension: 39-51 dynes/cm = 0.039-0.051 N/m at 20°C 13.10 Vapor (Gas) Specific Gravity: Data not available 13.11 Ratio of Specific Heats of Vapor (Gas): test 11.0.0 13.12 Latent Heat of Vaporization: 130-150 Btu/lb = 71-81 cal/g = 3.0-3.4 × 10 ⁵ J/kg 13.13 Heat of Combustion: test 1 - 18,200 Btu/lb = -10,100 cal/g = -424 × 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent
Category	Classification								
Health Hazard (Blue)	0								
Flammability (Red)	2								
Reactivity (Yellow)	0								
NOTES <div style="text-align: right;"><small>(Continued on pages 5 and 6.)</small></div>									

OMN

OILS, MISCELLANEOUS: MINERAL

Common Synonyms White oil Liquid Petroleum		Oily liquid Colorless Odorless Floats on water	
Stop discharge if possible. Call fire department. Avoid contact with liquid. Isolate and remove discharged material. Notify local health and pollution control agencies.			
Fire		Combustible. Extinguish with dry chemical, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.	
Exposure		CALL FOR MEDICAL AID LIQUID Irritating to skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.	
Water Pollution		Effect of low concentrations on aquatic life is unknown. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.	
1. RESPONSE TO DISCHARGE (See Response Methods Handbook CG 446-4) Mechanical containment Should be removed Chemical and physical treatment		2. LABELS No hazard label required by Code of Federal Regulations	
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Liquid petroleum White oil 3.2 Coast Guard Compatibility Classification: Miscellaneous hydrocarbon mixtures 3.3 Chemical Formula: Not applicable 3.4 IMCO/United Nations Numerical Designation: 1.1, 1.2		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Very faint	
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Goggles or face shield 5.2 Symptoms Following Exposure: Ingestion of liquid can cause very loose bowel movements. 5.3 Treatment for Exposure: EYES, wash with water. 5.4 Toxicity by Inhalation (Threshold Limit Value): Not pertinent 5.5 Short-Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion: Grade 1, 1 D, 5 to 1 g/kg 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: None 5.9 Liquid or Solid Irritant Characteristics: None 5.10 Odor Threshold: Not pertinent			

6. FIRE HAZARDS 6.1 Flash Point: 180°F O.C. 6.2 Flammable Limits in Air: Data not available 6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water or foam may cause frothing 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 500-700°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: 4 mm/min		8. WATER POLLUTION 8.1 Aquatic Toxicity: Data not available 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None									
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent		9. SELECTED MANUFACTURERS 1. Shell Oil Co. 1 Shell Plaza Houston, Tex. 77001 2. Standard Oil Co. (Indiana) 910 S. Michigan Ave. Chicago, Ill. 60605 3. Sun Oil Co. St. Davids, Pa. 19087									
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook CG 446-3) A-T-L		10. SHIPPING INFORMATION 10.1 Grades or Purity: Commercial, refined 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open (flame arrester)									
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Not listed 12.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 12.3 NFPA Hazard Classifications: <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>0</td> </tr> <tr> <td>Flammability (Red)</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>		Category	Classification	Health Hazard (Blue)	0	Flammability (Red)	1	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid 13.2 Molecular Weight: Not pertinent 13.3 Boiling Point at 1 atm: Very high 13.4 Freezing Point: Not pertinent 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 0.822 at 20°C (liquid) 13.8 Liquid Surface Tension: 27 dynes/cm = 0.027 N/m at 20°C 13.9 Liquid-Water Interfacial Tension: 47 dynes/cm = 0.047 N/m at 70°C 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 13.12 Latent Heat of Vaporization: Not pertinent 13.13 Heat of Combustion: Data not available 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent	
Category	Classification										
Health Hazard (Blue)	0										
Flammability (Red)	1										
Reactivity (Yellow)	0										
NOTES											

PCB

POLYCHLORINATED BIPHENYL

Common Synonyms PCB Chlorinated biphenyl Aroclor		Only liquid to solid powder Light yellow liquid, or white powder Weak odor Sinks in water
Stop discharge if possible. Keep people away. Avoid contact with liquid and solid. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.		
Fire	Combustible. Extinguish with water, foam, dry chemical, or carbon dioxide.	
Exposure	CALL FOR MEDICAL AID LIQUID OR SOLID Irritating to skin and eyes. Flush affected areas with plenty of water. IF IN EYES: hold eyelids open and flush with plenty of water.	
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.	
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446.4.)</small> Issue warning: water contaminant. Should be removed. Chemical and physical treatment.		2. LABELS No hazard label required by Code of Federal Regulations.
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Aroclor, Chlorinated biphenyl, Halogenated waxes, PCB, Polychlorobiphenyls. 3.2 Coast Guard Compatibility Classification: Not applicable. 3.3 Chemical Formula: $(C_{12}H_{10-x}Cl_x)_n$ 3.4 IMCO/United Nations Numerical Designation: Not listed.		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid or solid. 4.2 Color: Pale yellow (liquid), colorless (solid). 4.3 Odor: Practically odorless.
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Gloves and protective garments. 5.2 Symptoms Following Exposure: Acne from skin contact. 5.3 Treatment for Exposure: SKIN: wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): 0.5 to 1.0 mg/m ³ . 5.5 Short-Term Inhalation Limits: Data not available. 5.6 Toxicity by Ingestion: Grade 2; oral rat LD50 = 3980 mg/kg. 5.7 Late Toxicity: Causes chromosomal abnormalities in rats, birth defects in birds. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eyes and throat and cause eye and lung injury. They cannot be tolerated even at low concentrations. 5.9 Liquid or Solid Irritant Characteristics: Contact with skin may cause irritation. 5.10 Odor Threshold: Data not available.		

6. FIRE HAZARDS 6.1 Flash Point: >286°F. 6.2 Flammable Limits In Air: Data not available. 6.3 Fire Extinguishing Agents: Water, foam, dry chemical, or carbon dioxide. 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent. 6.5 Special Hazards of Combustion Products: Irritating gases are generated in fires. 6.6 Behavior In Fire: Not pertinent. 6.7 Ignition Temperature: Data not available. 6.8 Electrical Hazard: Not pertinent. 6.9 Burning Rate: Data not available.		8. WATER POLLUTION 8.1 Aquatic Toxicity: 0.278 ppm, 96 hr, bluegill; 11 µg, fresh water; 0.005 ppm, 3 Mo, Daphnia; 11 µg, salt water. 8.2 Waterfowl Toxicity: 1 Dy, 2000 ppm (mildard duck). 8.3 Biological Oxygen Demand (BOD): Very low. 8.4 Food Chain Concentration Potential: High.
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction. 7.2 Reactivity with Common Materials: No reaction. 7.3 Stability During Transport: Stable. 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent. 7.5 Polymerization: Not pertinent. 7.6 Inhibitor of Polymerization: Not pertinent.		9. SELECTED MANUFACTURERS Monsanto Industrial Chemicals Co. 800 North Lindbergh Blvd. St. Louis, Mo. 63166.
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 446.3.)</small> II		10. SHIPPING INFORMATION 10.1 Grades or Purity: 11 grades (some liquid, some solids) which differ primarily in their chlorine content (20.68% by weight). 10.2 Storage Temperature: Ambient. 10.3 Inert Atmosphere: No requirement. 10.4 Venting: Open.
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Not listed. 12.2 NAS Hazard Rating for Bulk Water Transportation: Not listed. 12.3 NFPA Hazard Classifications: Not listed.		13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Solid or liquid. 13.2 Molecular Weight: Not pertinent. 13.3 Boiling Point at 1 atm: Very high. 13.4 Freezing Point: Not pertinent. 13.5 Critical Temperature: Not pertinent. 13.6 Critical Pressure: Not pertinent. 13.7 Specific Gravity: 1.318 at 20°C (liquid). 13.8 Liquid Surface Tension: Not pertinent. 13.9 Liquid-Water Interfacial Tension: Not pertinent. 13.10 Vapor (Gas) Specific Gravity: Not pertinent. 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent. 13.12 Latent Heat of Vaporization: Not pertinent. 13.13 Heat of Combustion: Not pertinent. 13.14 Heat of Decomposition: Not pertinent. 13.15 Heat of Solution: Not pertinent. 13.16 Heat of Polymerization: Not pertinent.
(Continued on pages 1 and 6)		
NOTES		

REVISED 1978

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LITTLE (ARTHUR D) INC CAMBRIDGE MA

F/6 13/2

SPILL ASSESSMENT MODEL (SAM) PROCEDURE FOR MANUAL FIELD CALCULA--ETC(U)

APR 80 R 6 POTTS, J H HAGOPIAN

F08635-79-C-0084

UNCLASSIFIED

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DTIC

PYROGALLIC ACID


Common Synonyms Pyrogallol 1,2,3-Benzenetriol 1,2,3-Trihydroxybenzene	Solid White to Gray Odorless Sinks and mixes with water.
Avoid contact with solid and dust. Keep people away. Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Combustible. Extinguish with water, dry chemicals, foam, or carbon dioxide.
Exposure	CALL FOR MEDICAL AID DUST Irritating to eyes, nose and throat. If inhaled will cause coughing or difficult breathing. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. SOLID Irritating to skin and eyes. If swallowed will cause nausea, vomiting or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE <small>See Response Methods Handbook, CG 446-1</small> Issue warning - water contaminant Disperse and flush	
2. LABELS No hazard label required by Code of Federal Regulations	
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: 1,2,3-Benzenetriol; Pyrogallol; 1,2,3-Trihydroxybenzene 3.2 Coast Guard Competibility Classification: Not listed. 3.3 Chemical Formula: 1,2,3-C ₃ H ₃ (OH) ₃ 3.4 IMCO/United Nations Numerical Designation: Not listed	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Solid 4.2 Color: White to gray 4.3 Odor: None
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Rubber gloves, safety goggles, dust mask 5.2 Symptoms Following Exposure: Inhalation of dust causes irritation of nose and throat. Ingestion may cause severe gastrointestinal irritation, convulsions, circulatory collapse, and death. Contact with eyes causes irritation. Skin contact can cause local discoloration, irritation, scum, and death; repeated contact can cause sensitization. 5.3 Treatment for Exposure: (INHALATION) remove victim to fresh air. (INGESTION) give large amount of water; induce vomiting immediately, consult a physician. EYES: flush with water for at least 15 min.; consult a physician. SKIN: wash immediately with soap and water; consult a physician if exposure has been severe. 5.4 Toxicity by Inhalation (Threshold Limit Value): Data not available 5.5 Short-Term Inhalation Limits: Data not available 5.6 Toxicity by Ingestion: Grade 2 oral LD ₅₀ = 750 mg/kg (rat) 5.7 Late Toxicity: Decreases growth in chicks 5.8 Vapor (Gas) Irritant Characteristics: Data not available 5.9 Liquid or Solid Irritant Characteristics: Data not available 5.10 Odor Threshold: Odorless	

6. FIRE HAZARDS 6.1 Flash Point: Not pertinent (combustible solid) 6.2 Flammable Limits in Air: Not pertinent 6.3 Fire Extinguishing Agents: Water, foam, dry chemical, carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: 6.5 Special Hazards of Combustion Products: 6.6 Behavior in Fire: 6.7 Ignition Temperature: Data not available 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not pertinent	8. WATER POLLUTION 8.1 Aquatic Toxicity: 18 ppm/48 hr/goldfish/TLM/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 1.6%, 5 days 8.4 Food Chain Concentration Potential: None								
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS 1. The Harshaw Chemical Co. 1945 East 97 St. Cleveland, Ohio 44106 2. Aldrich Chemical Co. 940 W. Saint Paul Ave. Milwaukee, Wis. 53233 3. Eastman Organic Chemicals Rochester, N. Y. 14650								
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 446-3)</small> SS	10. SHIPPING INFORMATION 10.1 Grade or Purity: N.F. Reagent 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open								
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Not listed 12.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 12.3 NFPA Hazard Classifications: <table data-bbox="954 1419 1202 1493"> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td><td>1</td></tr> <tr> <td>Flammability (Red)</td><td>1</td></tr> <tr> <td>Reactivity (Yellow)</td><td>0</td></tr> </tbody> </table>	Category	Classification	Health Hazard (Blue)	1	Flammability (Red)	1	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Solid 13.2 Molecular Weight: 126 13.3 Boiling Point at 1 atm: 588°F = 309°C = 582°K 13.4 Freezing Point: 268°F = 131°C = 404°K 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 1.45 at 20°C (solid) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 13.12 Latent Heat of Vaporization: Not pertinent 13.13 Heat of Combustion: -4,130 Btu/lb = -5,070 cal/g = -212 × 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: Not pertinent 13.16 Heat of Polymerization: Not pertinent
Category	Classification								
Health Hazard (Blue)	1								
Flammability (Red)	1								
Reactivity (Yellow)	0								
NOTES									

(Continued on pages 1 and 2)

TOL

TOLUENE

Common Synonyms Toluid Methylbenzene Methylbenzol	Waters: liquid Colorless Pleasant odor Floats on water. Flammable, irritating vapor is produced.
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	Dangerous to aquatic life in high concentrations. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Issue warning: high flammability. Evacuate area.	2. LABEL 
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Methylbenzene Methylbenzol Toluol 3.2 Coast Guard Competibility Classification: Aromatic hydrocarbon 3.3 Chemical Formula: C ₇ H ₈ 3.4 IMCO/United Nations Numerical Designation: 1.2.1.294	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Pungent, aromatic, benzene-like, distinct, pleasant
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Air-supplied mask, goggles or face shield, plastic gloves. 5.2 Symptoms Following Exposure: Vapors irritate eyes and upper respiratory tract, cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration. 5.3 Treatment for Exposure: INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water. 5.4 Toxicity by Inhalation (Threshold Limit Value): 100 ppm 5.5 Short-Term Inhalation Limits: 600 ppm for 30 min 5.6 Toxicity by Ingestion: Grade 2, LD ₅₀ 5 to 5 g/kg 5.7 Late Toxicity: Kidney and liver damage may follow ingestion. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 0.17 ppm	

6. FIRE HAZARDS 6.1 Flash Point: 49°C (120°F) 6.2 Flammable Limits in Air: 1.27% - 7% 6.3 Fire Extinguishing Agents: Carbon dioxide or dry chemical for small fires; ordinary foam for large fires. 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 6.5 Special Hazards of Combustion Products: Not pertinent. 6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. 6.7 Ignition Temperature: 497°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 5.7 mm/min	8. WATER POLLUTION 8.1 Aquatic Toxicity: 100 mg/L 96 hr, sunlight, 11 m, fresh water. 8.2 Waterfowl Toxicity: Data not available. 8.3 Biological Oxygen Demand (BOD): 0 - 5 days, 80% (theoretical) days. 8.4 Food Chain Concentration Potential: None.																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction. 7.2 Reactivity with Common Materials: No reaction. 7.3 Stability During Transport: Stable. 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent. 7.5 Polymerization: Not pertinent. 7.6 Inhibitor of Polymerization: Not pertinent.	9. SELECTED MANUFACTURERS 1. Exxon Chemical Co. Houston, Tex. 77001 2. Shell Chemical Co. Petrochemicals Division Houston, Tex. 77001 3. Sun Oil Co. St. Davids, Pa. 19087																																				
11. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook, CG 446-3) A-E	10. SHIPPING INFORMATION 10.1 Grades or Purity: Research, reagent, nitration - all 99.8+%, industrial - contains 94+%, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons, 90-120 less pure than industrial. 10.2 Storage Temperature: Ambient. 10.3 Inert Atmosphere: No requirement. 10.4 Venting: Open flame arrester or pressure-vacuum.																																				
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Flammable liquid. 12.2 NAS Hazard Rating for Bulk Water Transportation: <table data-bbox="908 1344 1156 1575"> <thead> <tr> <th>Category</th><th>Rating</th></tr> </thead> <tbody> <tr> <td>Fire</td><td>3</td></tr> <tr> <td>Health</td><td></td></tr> <tr> <td> Vapor Irritant</td><td>1</td></tr> <tr> <td> Liquid or Solid Irritant</td><td>1</td></tr> <tr> <td> Poisons</td><td>2</td></tr> <tr> <td>Water Pollution</td><td></td></tr> <tr> <td> Human Toxicity</td><td>1</td></tr> <tr> <td> Aquatic Toxicity</td><td>3</td></tr> <tr> <td> Aesthetic Effect</td><td>2</td></tr> <tr> <td>Reactivity</td><td></td></tr> <tr> <td> Other Chemicals</td><td>1</td></tr> <tr> <td> Water</td><td>0</td></tr> <tr> <td> Self-Reaction</td><td>0</td></tr> </tbody> </table> 12.3 NFPA Hazard Classifications: <table data-bbox="908 1596 1156 1701"> <thead> <tr> <th>Category</th><th>Classification</th></tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td><td>2</td></tr> <tr> <td>Flammability (Red)</td><td>3</td></tr> <tr> <td>Reactivity (Yellow)</td><td>0</td></tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self-Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Liquid. 13.2 Molecular Weight: 92.14. 13.3 Boiling Point at 1 atm: 231.1°F = 110.6°C = 383.8°K 13.4 Freezing Point: -109°F = -95.0°C = 178.2°K 13.5 Critical Temperature: 605.4°F = 318.6°C = 591.8°K 13.6 Critical Pressure: 596.1 psia = 40.55 atm = 4.108 MN/m ² 13.7 Specific Gravity: 0.867 at 20°C (liquid) 13.8 Liquid Surface Tension: 29.0 dynes/cm = 0.0290 N/m at 20°C 13.9 Liquid-Water Interfacial Tension: 36.1 dynes/cm = 0.0361 N/m at 25°C 13.10 Vapor (Gas) Specific Gravity: Not pertinent. 13.11 Ratio of Specific Heats of Vapor (Gas): 1.089 13.12 Latent Heat of Vaporization: 155 Btu/lb = 86.1 cal/g = 3.61 × 10 ⁵ J/kg 13.13 Heat of Combustion: -17,430 Btu/lb = -9686 cal/g = -405.5 × 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent. 13.15 Heat of Solution: Not pertinent. 13.16 Heat of Polymerization: Not pertinent.
Category	Rating																																				
Fire	3																																				
Health																																					
Vapor Irritant	1																																				
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NOTES <small>(Continued on pages 5 and 6)</small>																																					

TCL

TRICHLOROETHYLENE

Common Synonyms Trichloroethene Trieine	Watery liquid Colorless Sweet odor Sinks in water. Irritating vapor is produced.
Stop discharge if possible. Keep people away. Avoid contact with liquid and vapor. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Combustible POISONOUS GASES ARE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, or foam.
Exposure	CALL FOR MEDICAL AID VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea, vomiting, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, difficult breathing, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CON- VULSIONS, do nothing except keep victim warm.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook, CG 446-4) Should be removed. Chemical and physical treatment.	2. LABELS No hazard label required by Code of Federal Regulations.
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Alysene, Chlorylene, Gemalgene, Threthylene, Trethylene, Tri, Trichloran, Trichloroethene, Tri- Clene, Trielene, Trilene, Triline, Trimar. 3.2 Coast Guard Competibility Classification: Halogenated hydrocarbon. 3.3 Chemical Formula: C_2HCl_3 3.4 IMCO/United Nations Numerical Designation: 9.0/1710	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Chloroform-like, ethereal
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Organic vapor-acid gas canister, self-contained breathing apparatus for emergencies, neoprene or vinyl gloves, chemical safety goggles, face shield, neoprene safety shoes, neoprene suit or apron for splash protection. 5.2 Symptoms Following Exposure: INHALATION: symptoms range from irritation of the nose and throat to nausea, an attitude of irresponsibility, blurred vision, and finally disturbance of central nervous system resulting in cardiac failure. Chronic exposure may cause organic injury. INGESTION: symptoms similar to inhalation. SKIN: defatting action can cause dermatitis. EYES: slight irritant sensation and lachrymation. 5.3 Treatment for Exposure: Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting, repeat three times, then give 1 tablespoon epsom salts in water. EYES: flush thoroughly with water. SKIN: wash thoroughly with soap and warm water. 5.4 Toxicity by Inhalation (Threshold Limit Value): 100 ppm 5.5 Short-Term Inhalation Limits: 200 ppm for 10 min 5.6 Toxicity by Ingestion: Grade 1, LD ₅₀ 50 to 500 mg/kg 5.7 Lethal Toxicity: Data not available. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 50 ppm	

6. FIRE HAZARDS

- 6.1 Flash Point: 90°F (32°C), practically
nonflammable.
6.2 Flammable Limits in Air: 8.0% - 10.5%
6.3 Fire Extinguishing Agents: Water fog.
6.4 Fire Extinguishing Agents Not to be Used:
Not pertinent.
6.5 Special Hazards of Combustion Products:
Toxic and irritating gases are produced
in fire situations.
6.6 Behavior in Fire: Not pertinent.
6.7 Ignition Temperature: 770 °F.
6.8 Electrical Hazard: Not pertinent.
6.9 Burning Rate: Not pertinent.

7. CHEMICAL REACTIVITY

- 7.1 Reactivity with Water: No reaction.
7.2 Reactivity with Common Materials:
No reaction.
7.3 Stability During Transport: Stable.
7.4 Neutralizing Agents for Acids and
Caustics: Not pertinent.
7.5 Polymerization: Not pertinent.
7.6 Inhibitor of Polymerization: Not pertinent.

8. WATER POLLUTION

- 8.1 Aquatic Toxicity:
660 mg/L 40 hr daphnia kill, fresh water.
8.2 Waterfowl Toxicity: Data not available.
8.3 Biological Oxygen Demand (BOD):
Data not available.
8.4 Food Chain Concentration Potential:
None.

9. SELECTED MANUFACTURERS

- Dow Chemical Co.
Midland, Mich. 48640
- E. I. duPont de Nemours & Co., Inc.
Electrochemicals Dept.
Wilmington, Del. 19898
- PPG Industries Inc.
Industrial Chemical Division
Lake Charles, La. 70601

10. SHIPPING INFORMATION

- 10.1 Grades or Purity: Technical, dis-
cleaning, degreasing, extraction.
10.2 Storage Temperature: Ambient.
10.3 Inert Atmosphere: No requirements.
10.4 Venting: Pressure vacuum.

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG 446-3)
A-X-Y

12. HAZARD CLASSIFICATIONS

- 12.1 Code of Federal Regulations:
ORM A
12.2 NAS Hazard Rating for Bulk Water
Transportation:
- | Category | Rating |
|--------------------------|--------|
| Fire | 1 |
| Health | 1 |
| Vapor Irritant | 1 |
| Liquid or Solid Irritant | 1 |
| Poisons | 2 |
| Water Pollution | 1 |
| Human Toxicity | 1 |
| Aquatic Toxicity | 2 |
| Aesthetic Effect | 2 |
| Reactivity | 1 |
| Other Chemicals | 1 |
| Water | 0 |
| Self-Reaction | 1 |

12.3 NFPA Hazard Classifications: Not listed

13. PHYSICAL AND CHEMICAL PROPERTIES

- 13.1 Physical State at 15°C and 1 atm: Liquid.
13.2 Molecular Weight: 131.19
13.3 Boiling Point at 1 atm:
189°F = 87°C = 361°K
13.4 Freezing Point:
-123.5°F = -86.4°C = 186.8°K
13.5 Critical Temperature: Not pertinent.
13.6 Critical Pressure: Not pertinent.
13.7 Specific Gravity: 1.46 at 20°C (liquids)
13.8 Liquid Surface Tension:
29.1 dynes/cm = 0.0291 N/m at 20°C
13.9 Liquid-Water Interfacial Tension:
34.5 dynes/cm = 0.0345 N/m at 24°C
13.10 Vapor (Gas) Specific Gravity: 4.5
13.11 Ratio of Specific Heats of Vapor (Gas):
1.116
13.12 Latent Heat of Vaporization:
103 Btu/lb = 57.2 cal/g = 2.40 x 10⁵ J/kg
13.13 Heat of Combustion: Not pertinent.
13.14 Heat of Decomposition: Not pertinent.
13.15 Heat of Solution: Not pertinent.
13.16 Heat of Polymerization: Not pertinent.

(Continued on pages 5 and 6)

NOTES

URE

UREA

Common Synonyms Carbamide Carbonyl diamide	Solid crystals or pellets White Odorless Sinks and mixes with water.
Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Combustible Extinguish with water.
Exposure	Not harmful.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE <small>(See Response Methods Handbook, CG 446-4)</small> Disperse and flush.	2. LABELS No hazard label required by Code of Federal Regulations.
3. CHEMICAL DESIGNATIONS 3.1 Synonyms: Carbamide, Carbonyl diamide 3.2 Coast Guard Compatibility Classification: Not applicable 3.3 Chemical Formula: NH_2CONH_2 3.4 IMCO United Nations Numerical Designation: Not listed	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Solid 4.2 Color: White 4.3 Odor: Odorless, or slight ammonia odor
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Goggles or face shield, dust mask 5.2 Symptoms Following Exposure: May irritate eyes 5.3 Treatment for Exposure: Wash eyes with water 5.4 Toxicity by Inhalation (Threshold Limit Value): Not pertinent 5.5 Short-Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion: Data not available 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Non-volatile 5.9 Liquid or Solid Irritant Characteristics: None 5.10 Odor Threshold: Not pertinent	

6. FIRE HAZARDS 6.1 Flash Point: Not flammable 6.2 Flammable Limits in Air: Not flammable 6.3 Fire Extinguishing Agents: Water 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Melts and decomposes, generating ammonia 6.7 Ignition Temperature: Not flammable 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not flammable	8. WATER POLLUTION 8.1 Aquatic Toxicity: 10,000 mg/L 14 hr, creek chub, all dead, fresh water 10,000 mg/L 14 hr, creek chub, all survived, fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 9% 5-day 8.4 Food Chain Concentration Potential: None
7. CHEMICAL REACTIVITY 7.1 Reactivity with Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Occurs only above melting point (132°C), yielding ammonia and other products. The decomposition is not explosive. 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	9. SELECTED MANUFACTURERS 1. Allied Chemical Corp. Agricultural Division Morristown, N. J. 07960 2. East-Six-Gate Co. Nopak Inc. Division Dallas, Tex. 75221 3. East Chemical Co. Yazoo City, Miss. 39394
11. HAZARD ASSESSMENT CODE <small>(See Hazard Assessment Handbook, CG 446-3)</small> SS	10. SHIPPING INFORMATION 10.1 Grades or Purity: Various grades and purities, which depend on manufacturing process and intended use. All have essentially the same hazardous properties. 10.2 Storage Temperature: Ambient 10.3 Inert Atmosphere: No requirement 10.4 Venting: Open
12. HAZARD CLASSIFICATIONS 12.1 Code of Federal Regulations: Not listed 12.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 12.3 NEPA Hazard Classifications: Not listed	13. PHYSICAL AND CHEMICAL PROPERTIES 13.1 Physical State at 15°C and 1 atm: Solid 13.2 Molecular Weight: 60.06 13.3 Boiling Point at 1 atm: Decomposes 13.4 Freezing Point: 271.1° = 133.0° = 406° K 13.5 Critical Temperature: Not pertinent 13.6 Critical Pressure: Not pertinent 13.7 Specific Gravity: 1.34 at 20°C (solid) 13.8 Liquid Surface Tension: Not pertinent 13.9 Liquid-Water Interfacial Tension: Not pertinent 13.10 Vapor (Gas) Specific Gravity: Not pertinent 13.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 13.12 Latent Heat of Vaporization: Not pertinent 13.13 Heat of Combustion: -891.4 Btu/lb = -2174 cal/g = -91.02 x 10 ³ J/kg 13.14 Heat of Decomposition: Not pertinent 13.15 Heat of Solution: -108 Btu/lb = -60.1 cal/g = -252 x 10 ³ J/kg 13.16 Heat of Polymerization: Not pertinent
NOTES	

(Continued on pages 4 and 6)

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NESO	1		
NCEL, Code 15111	1		
Commandant/GDD	1		
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